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Physics Abstracts

PAGE
MATHEMATICS 611
ASTROPHYSICS 611
PHYSICS 615
General 615
Gravitation. Relativity 615
Field theory. Quantum theory 617
Statistical mechanics. Transfer processes 620
General mechanics. Mechanics of solids 622
Mechanical measurements 623
Mechanics of fluids 623
Molecular theory of liquids 625
Mechanics of gases. Vacuum technique 626
Molecular theory of gases 627
Vibrations. Acoustics 627
Optics. Spectra. Luminescence 634
Heat 649
Thermodynamics 652
Electricity 653
Electrostatics. Dielectrics 653
Electric conduction. Semiconductors 657
Electric discharges 668
X-rays 670
Electron emission. Electron beams 672
Ion emission. Ion beams 675
Particle accelerators 676
Ionization. Plasma 677
Cosmic rays 679
Magnetism. Magnetic Resonances 680

PAGE
Electromagnetism. Magnetohydrodynamics 686
Electromagnetic waves and oscillations 687
Nuclear and atomic physics 688
Apparatus. Particle detectors 688
Elementary particles 690
Nucleus 695
Radioactivity 696
Nuclear reactions 699
Atoms 704
Molecules 706
Solid-state physics 713
Structure of solids 717
Elasticity. Strength. Rheology 719
PHYSICAL CHEMISTRY 721
Phase equilibrium. Chemical reactions 721
Electrochemistry 723
Photochemistry. Radiation chemistry 723
Dispersions. Colloids. Adsorption 724
Chemical analysis 724
CRYSTALLOGRAPHY 725
X-ray crystallography 726
GEOPHYSICS 731
Atmosphere. Ionosphere 732
BIOPHYSICS. PHYSIOLOGICAL PHYSICS 736
TECHNIQUE. MATERIALS 738
Photography 738

The number printed above each abstract on the right is the Universal Decimal subject classification number; the abstracts are arranged in order of these numbers throughout each issue.

The monthly Author Index, List of Journals, Errata and Notes follow immediately after the last page of abstracts.

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Electrical and magnetic measurements and instruments
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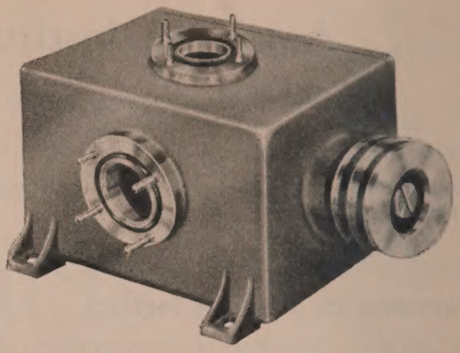

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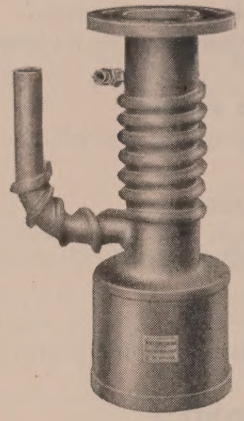

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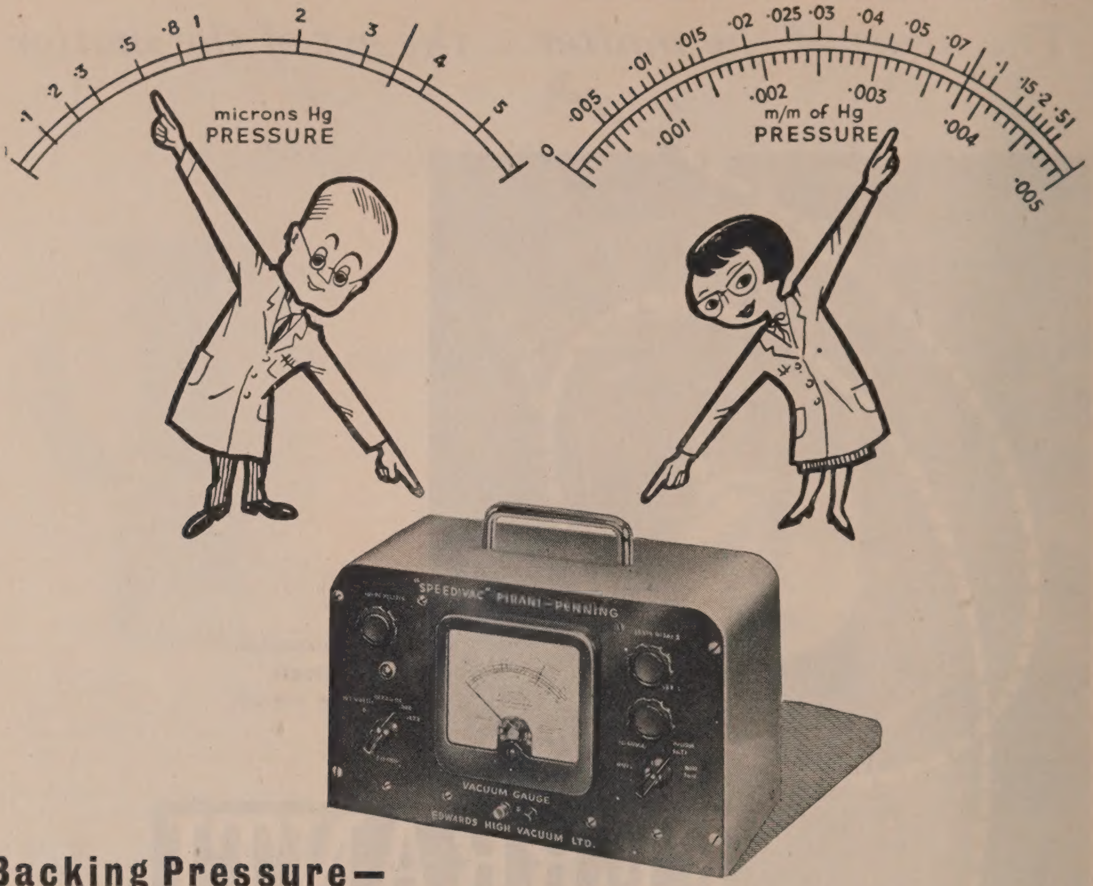
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PHYSICS ABSTRACTS

Volume 62 JULY 1959 Number 739

MATHEMATICS

517.564.4

6435. THE SPHERICAL FUNCTIONS OF LEGENDRE AND SPHEROIDAL FUNCTIONS. VOLUME II. [Fonctions sphérique de Legendre et fonctions sphéroïdales]. L.Robin.
Paris: Gauthier-Villars (1958) viii + 384 pp. [Collection Technique et Scientifique du C.N.E.T.]. In French.

For Volume I, see Abstr. 2089 (1958). Volume I served as an introduction to the Legendre functions P_n^m and Q_n^m for integral values of n and m ($n \geq 0$), and their applications in mathematical physics. The present volume, comprising Chapters 4, 5 and 6 of the complete work is a continuation in every sense of the previous one, and is concerned with the corresponding functions when n and m take any values whatever, real or complex. Chapter 4 deals with the relation of the generalized Legendre functions to the hypergeometric function of Gauss and to the Riemann P-function, their general properties and integral representations involving Bessel functions. Chapter 5 sets forth convergent and asymptotic expansions for these functions under various conditions, and inequalities satisfied by them. Chapter 6 deals with series of Legendre polynomials, of associated Legendre functions and of Laplace polynomials. Brief mention is made of their extension to Euclidean spaces of more than three dimensions and of the Gibbs' phenomenon. The book is a veritable store of mathematical results, and the historical background of the subject has not been overlooked. There are twenty-seven diagrams. T.R.Carson

517.6

6436. EXPONENTIAL INTEGRAL $\int_1^\infty e^{-xt}t^{-n}dt$ FOR LARGE VALUES OF n. W.Gautschi.
J. Res. Nat. Bur. Stand., Vol. 62, No. 3, 123-5 (March, 1959).

An asymptotic expansion is given which is well suited for numerical computation when n is large and x arbitrary positive.

517.9

6437. A NEW METHOD OF SOLVING BOUNDARY VALUE PROBLEMS OF MATHEMATICAL PHYSICS. P.Shuleshko.
Austral. J. appl. Sci., Vol. 10, No. 1, 1-8 (March, 1959).

In this method a wider class of functions than usual (Rayleigh—Ritz, Boobnoff—Galerkin, Biezeno—Koch, Trefftz, etc.) can be used. Those used must satisfy only one condition, namely, that the set of functions should be complete. By way of placing additional conditions on chosen functions a series of special methods has been derived. One example is given illustrating the application of the method to the condition.

517.9

6438. GENERALIZATION OF PREVIOUS METHODS OF SOLVING BOUNDARY VALUE PROBLEMS OF MATHEMATICAL PHYSICS. P.Shuleshko.
Austral. J. appl. Sci., Vol. 10, No. 1, 9-16 (March, 1959).

A generalized method of orthogonalization for the solution of boundary value problems of mathematical physics is given. Also a generalized Biezeno—Koch method, a generalized collocation method, and a generalized method of least squares are given. In these methods, a wider class of functions, than in the usual known methods, can be used. It is shown that a generalized Biezeno—Koch method and a generalized method of least squares can be derived as particular cases of the generalized method of orthogonalization. From these methods a series of special methods has been derived by placing additional conditions on chosen functions.

519.2 : 535.345

RADIATIVE TRANSPORT FROM POINT SOURCES IN A STRATIFIED MEDIUM. See Abstr. 5553

519.2 : 612.843.72

STATISTICAL TREATMENT OF MEASUREMENTS ON THE PERCEPTUAL PROPERTIES OF THE HUMAN EYE. See Abstr. 6420

ASTROPHYSICS

52 : 551.5

6439. SPACE RESEARCH. R.L.F.Boyd.
Nature (London), Vol. 183, 361-4 (Feb. 7, 1959).

Report of a conference arranged by the Royal Society on Nov. 12-13, 1958, at which achieved and projected experiments in rockets and artificial satellites were discussed. Summaries are given of the main points treated, viz. oblateness of the earth; atmospheric composition and temperature, including ionospheric measurements; cosmic rays; Van Allen radiation belt and its association with aurorae; micrometeors; extra-terrestrial astronomy, including the use of optical, radio, X-ray, and γ-ray wavelengths; studies of the Moon, Mars and Venus. Practical problems include the recovery of information and position determination. The interpretation of the results obtained include the possibility that the Earth is situated in an extended solar corona. G.M.Brown

522.613 : 551.521.326

6440. BRIGHTNESS STANDARD FOR NIGHT AIRGLOW PHOTOMETERS OF OI λ5577. R.Onaka and M.Nakamura.
Sci. of Light (Tokyo), Vol. 7, No. 2, 28-32 (Aug., 1958).

A tungsten filament light-source is run at 1900°K, and converted by means of a suitable colour filter to an effective colour temperature of 6000°K. The source illuminates an opal glass diffusing screen mounted over the aperture of the nightglow photometer, the combination of lamp, filter and screen acting as an artificial sky of uniform brightness. The absolute brightness value was found by direct comparison with a calibrated tungsten lamp used as a primary standard of illumination. D.R.Barber

522.614.2

6441. AN INTERFEROMETRIC DEVICE FOR THE EXAMINATION OF STELLAR SPECTRA USING BLACKENED [SILVER] RELIEF IMAGES. H.Schmidt and J.Engelbrecht.
Z. InstrumKde, Vol. 66, No. 11, 227-30 (Nov., 1958). In German.

A comparatively inexpensive optical apparatus is described whereby the incident flux of starlight at any given wavelength of a low-dispersion, photographically recorded spectrogram may be measured with high precision. On development of the negative, the line spectrum is reproduced as a sequence of blackened silver relief images of varying heights dependent on the incident intensity. The heights of these strip elements are measured to a high order of accuracy by the aid of a specially designed interference microscope utilizing the Michelson principle. D.R.Barber

523.11

6442. A REVISED TABLE OF ABUNDANCES OF THE ELEMENTS. A.G.W.Cameron.
Astrophys. J., Vol. 129, No. 3, 676-99 (May, 1959).

The semiempirical abundance table of Suess and Urey has been very helpful to nuclear physicists in determining the relative importance of various mechanisms of nucleogenesis in contributing to the natural abundances of the elements. The table was based primarily on abundance determinations in chondritic meteorites, together with the hypothesis that the abundances of odd mass-number nuclides should lie on a smooth curve. It has recently become apparent that certain elements are over- or under-abundant in the chondritic meteorites without apparent chemical reason. In order to throw additional light on such discrepancies, and on certain less well-understood mechanisms of nucleogenesis, the abundance-curve has been re-examined, using some additional nucleogenesis-based criteria for the abundances of even mass-number nuclides, and a new table of abundances has been constructed. It was found necessary to change the Suess–Urey table substantially in the rare-earth region and in the lead region and to make isolated changes in the abundances of certain additional elements. Some conclusions have been drawn regarding the process of neutron capture on a fast time scale and the methods of production of bypassed heavy nuclei.

523.11

6443. VELOCITY ELLIPSOIDS AND THE GRAVITATIONAL POTENTIAL OF THE GALAXY. P.A.Wayman.
Monthly Not. Roy. Astron. Soc., Vol. 119, No. 1, 34-45 (1959).

It is found that, with a little modification, Schmidt's model (1956) can be regarded as an example of a type of steady-state galaxy described by Camm (1941). The velocity ellipsoid at the sun's radius in this type of galaxy may have three unequal axes and it is possible to discuss the variation of these axes in different parts of the galaxy. One result is a tilt of the "direction of star-streaming" a fairly short distance above or below the galactic plane.

523.11

6444. THE RED SHIFT–MAGNITUDE RELATION IN OBSERVATIONAL COSMOLOGY. W.Davidson.
Monthly Not. Roy. Astron. Soc., Vol. 119, No. 1, 54-66 (1959).

A reappraisal is made of earlier theoretical work on the red shift–magnitude relation. New formulae are derived which are particularly directed to the practical solution of the cosmological problem and the detection of evolutionary effects.

523.161 : 532.5 : 538.3

INFLUENCE OF INTERSTELLAR MAGNETIC FIELDS ON NON-MAGNETIC GAS CLOUDS. See Abstr. 5958

523.164

6445. DISTORTION OF RADIOASTRONOMICAL OBSERVATIONS BY AERIAL CHARACTERISTICS AND FILTERS. P.Mezger.
Z. InstrumKde, Vol. 66, No. 11, 2 9-27 (Nov., 1958). In German.

The limitations imposed on measurements in radioastronomy by finite aerial beamwidth and receiver output time constant are discussed. A relation is derived which connects output time constant with aerial beamwidth and aerial scanning speed to give minimum distortion of the observed radiation distribution. Positional errors which depend on these parameters are also evaluated.
H.J.A.Chivers

523.164.32

6446. ANOMALOUS NIGHT-TIME RECEPTION OF A MAJOR SOLAR RADIO BURST. A.G.Smith, T.D.Carr and W.H.Perkins.
Nature (London), Vol. 183, 597-8 (Feb. 28, 1959).

At 0235 U.T. (some 4 hours before sunrise) on 8 March 1958, radio emission was observed at the Florida Radio Observatory on five receivers in the frequency range 18 to 27.6 Mc/s. The characteristics of this event suggest that it was of solar origin. Observations in the sunlit hemisphere at higher frequencies revealed an intense solar outburst at this time. The low frequency observations are compatible with reflections of solar emission from the moon. It is pointed out that anomalous propagation through the ionosphere is also a possible explanation. R.D.Davies

523.164.4

6447. POSSIBLE SOURCES OF RADIO EMISSION IN CLUSTERS OF GALAXIES. G.R.Burbidge.
Astrophys. J., Vol. 128, No. 1, 1-8 (July, 1958).

A number of the strongest extragalactic sources of radio emission are situated in rich clusters of galaxies. Although in most cases the major contribution to the emission comes from the vicinity of a single abnormal galaxy, there is some preliminary evidence that a fraction of the emission may come from regions which lie outside the visible abnormal system. It is suggested that such regions are likely to be intergalactic clouds containing a weak magnetic field. On the assumption that synchrotron radiation is responsible for the emission, it is shown that, under optimum conditions, the magnetic fields in the radiating regions will be $\sim 10^{-7}$ G, while the electron energies will lie in the range 10^{9}-10^{10} eV. The total (particle + magnetic) energy then lies in the range 10^{59}-10^{61} ergs. It appears that in highly condensed clusters some of this energy can be derived from the internal kinetic energy of the cluster, the particles gaining energy from Fermi collisions with the galaxies and intergalactic clouds, while the magnetic energy is also probably increased in galactic or cloud collisions.

523.164.4

6448. THE RADIO EMISSION FROM THE DIRECTION OF THE "SUPERGALAXY". J.R.Shakeshaft and J.E.Baldwin.
Monthly Not. Roy. Astron. Soc., Vol. 119, No. 1, 46-53 (1959).

Observations have been made with the Cambridge radio telescope at a wavelength of 1.9 m from which radio isophotes of the region of sky 10^{h}-14^{h} have been derived in order to investigate the features which have been ascribed to radiation from the "local supergalaxy". The distribution of emission is not closely correlated with counts of galaxies. The observed intensities are several times greater than those to be expected from normal galaxies and counts of radio sources show that this factor cannot be explained by a small proportion of the galaxies having abnormally high radio luminosities. The radio brightness of one of the features is very large compared with the total background of extra-galactic emission. It is suggested that the radio features are not in fact associated with the "supergalaxy".

523.165 : 537.591

POINT SOURCE OF COSMIC RAYS IN ORION. See Abstr. 5857

523.5

6449. THE INFLUX RATE OF METEORS IN THE EARTH'S ATMOSPHERE. G.S.Hawkins and E.K.L.Upton.
Astrophys. J., Vol. 128, No. 3, 727-35 (Nov., 1958).

Photographic observations obtained with Super Schmidt cameras are used to determine the rate of incidence of meteoric particles on the earth's upper atmosphere. The rate is expressed as a function of the photographic and visual magnitude of the meteor, the electron line density of the trail, and the mass of the original meteoroid. It is shown that the number of meteors increases by a factor of 3.4 ± 0.2 per magnitude. The total number of meteors brighter than a visual magnitude of +5 which enter the atmosphere in 24 hr is 90 million.

523.51 : 533.6

6450. THE TRANSITIONAL AERODYNAMIC DRAG OF METEORITES. R.M.L.Baker, Jr.
Astrophys. J., Vol. 129, No. 3, 826-41 (May, 1959).

The theory of transitional aerodynamic drag is applied to meteorites, and an analytical expression for the variation in the drag coefficient is proposed that is more realistic than the almost universally employed constant value of 2. The terms micro-, meso-, and macrometeorites are proposed and defined, and typical members of each of these three categories of meteorites are selected for analysis. Plots of speed v. altitude are presented that indicate the importance of transitional drag for these three meteoritic categories. The transitional drag of an infinitesimal disk is developed in an appendix.

523.51

6451. INVESTIGATION OF THE PHASE COMPOSITION OF IRON METEORITES BY X-RAY MICRO-ANALYSIS.
A.A.Yavnel', I.B.Borovski, N.P.Il'in and I.D.Marchukova.
Dokl. Akad. Nauk SSSR, Vol. 123, No. 2, 256-8 (1958). In Russian.

Describes measurements of the nickel, iron, and cobalt content of selected areas of the Chebankol meteorite (1938). Local analysis shows that equilibrium conditions were not reached during the formation of the meteorite. T.Mulvey

523.51 : 539.231

6452. SPUTTERING AS IT IS RELATED TO HYPERBOLIC METEORITES. R.M.L.Baker, Jr.
J. appl. Phys., Vol. 30, No. 4(1), 550-5 (April, 1959).

A theoretical discussion is presented of the phenomenon of cathode sputtering as it is related to high-speed meteorites, i.e., to meteorites whose speeds are high enough to have reached the Earth from interstellar space. The drag and heat transfer are found to be markedly affected by sputtering, even when the most conservative estimates of sputtering-yield and energy-transfer efficiency are employed. The paper shows that theoretically sputtering can account in part, at least, for the discrepancy between meteor photographs, which show no extra-solar meteorites, and certain visual-telescopic data which, on the contrary, show a significant number of meteorite to have an extra-solar origin.

523.51 : 545.8

A NEW METHOD OF ESTIMATING SMALL URANIUM CONTENTS AND ITS APPLICATION TO THE URANIUM ANALYSIS OF STONE METEORITES. See Abstr. 6354

523.72

6453. THEORY AND OBSERVATIONS OF POLARIZATION IN SOLAR FRAUNHOFER LINES. F.W.Jäger.

Z. Astrophys., Vol. 43, No. 2, 98-121 (1957). In German.

In continuation of existing theories, the theory of polarization for solar absorption lines is developed for the centre of a line formed mostly by coherent scattering. The influence of a magnetic field and of partly polarized incident light has also been considered. New photographic observations of the Ca resonance line λ 4227 A at the limb and in the centre of the sun's disc were taken with an improved equipment at the Göttingen solar tower. The observed degrees of polarization are in good agreement with calculation; it is therefore concluded that coherent scattering is important for the radiative transfer within a line of that type.

523.72

6454. THE CORPUSCULAR RADIATION FROM N- AND S-HEMISPHERES OF THE SUN. W.Gleissberg.

Z. Astrophys., Vol. 43, No. 2, 144-8 (1957). In German.

Using as criteria mean values of the daily geomagnetic (C_i) character figures covering the seven 11-year sunspot cycles, 1884-1949, for days when either high N- or S- heliographic latitudes were facing the earth, it is shown that, except for the two cycles, 1913-1922 and 1923-1932, the N—S difference of C_i is always negative, indicating a greater corpuscular emission from the S-hemisphere of the sun. For both exceptions the difference is found to be positive.

D.R.Barber

523.73

6455. ROTATION OF THE SUN FROM OBSERVATIONS OF HIGH LATITUDE SUNSPOTS. M.Waldmeier.

Z. Astrophys., Vol. 43, No. 1, 29-35 (1957). In German.

The sun's rotation has been computed from observations of a unipolar spot crossing the sun's disk from August 15 to 31, 1956 at the latitude of 48.3°. At this latitude the daily sideral motion amounts to $12.35^\circ \pm 0.15^\circ$, far less than was expected from the Greenwich formula for the latitude dependence of the solar rotation. The rotation derived from the spot is even slower than that derived from the filaments at the same latitude, showing the angular velocity to increase with height.

523.74 : 551.594.221

6456. SOLAR ACTIVITY AND WHISTLER DISPERSION. G.McK.Allcock and M.G.Morgan.

J. geophys. Res., Vol. 63, No. 3, 573-6 (Sept., 1958).

Measurements of the time delay between the atmospheric "bonk" of a lightning flash, and the appearance of the highest audible component of the accompanying whistler, show similar variations from month to month, for all locations for which sufficient data exist. The form of this variation correlates strongly with the sunspot number, with a time lag of one or two months. The change in dispersion is attributed to a general change in the electron density throughout the outer ionosphere. It is suggested that this provides further evidence in favour of the statement that "the earth may be revolving around the sun within the solar corona".

G.D.Sims

523.741

6457. ON THE USE OF THE EARLY BALMER LINES TO EXTEND THE PHOTOSPHERIC MODEL.

R.G.Athay and R.N.Thomas.

Astrophys. J., Vol. 127, No. 1, 96-107 (Jan., 1958).

The early Balmer lines in the solar Fraunhofer spectrum provide information relative to the structure of the solar atmosphere. The present analysis of these lines in the disk spectrum indicates that the lines are not formed in local thermodynamic equilibrium, so that the source function is not given by $B_\nu(T_e)$. The combined empirical and theoretical results lead one to conclude that the source function for the Balmer lines is determined to the first order by the radiation field in Hα and to the second order by the changes in electron temperature. The central intensities of the early Balmer lines show limb darkening out to $\cos\theta \geq 0.1$. Just beyond the limb, Hβ, Hγ, and Hδ show limb brightening, whereas Hα shows constant brightness and the lines H10 and above show further limb darkening. The limb brightening in Hβ, Hγ, and Hδ may be attributed to decreasing opacity in the early Lyman lines without necessarily changing the electron temperature. The absence of limb brightening in Hα may be attributed to high opacity in the spicules, and the absence of limb brightening in Hα may be attributed to high opacity in the spicules, and the absence of limb brightening in the lines H10 and above may be attributed to lower opacity in these lines than in the earlier lines.

523.745

6458. RADIATION AND PARTICLE PRECIPITATION UPON THE EARTH FROM SOLAR FLARES. L.Biermann and R.Lüst.

Proc. Inst. Radio Engrs, Vol. 47, No. 2, 209-10 (Feb., 1959).

A brief survey of the main features of solar emissions in connection with solar flares is given: ultraviolet and X-ray radiation, corpuscular emission, radio frequency radiation, and relativistic particles. For these different components of nonthermal emissions the energies are estimated and their effects in the ionosphere are briefly discussed.

523.746

6459. ON THE STRUCTURE AND MECHANISM OF SUNSPOTS. A.Dauvillier.

C.R. Acad. Sci. (Paris), Vol. 248, No. 8, 1084-6 (Feb. 23, 1959). In French.

The author's explanation (1932) of solar activity in terms of the properties of electric discharges in a gaseous medium is extended in a qualitative manner to a discussion of the nature of sunspots. The mechanical effects are regarded as due to gaseous vortices and not to convection.

R.A.Newing

523.75

6460. EXCITATION TEMPERATURES AND TURBULENT VELOCITIES IN SUNSPOTS. R.Howard.

Astrophys. J., Vol. 127, No. 1, 108-17 (Jan., 1958).

High-dispersion spectra of several small and medium-sized sunspots were obtained with the 16 in. coronagraph of the Sacramento Peak Observatory. Equivalent widths and half-widths were measured. A curve of growth was constructed for each spot. Excitation temperatures for iron derived from the curve-of-growth analysis averaged 4100°, assuming an excitation temperature of 4900° for the photosphere. There is evidence for a higher excitation temperature for smaller spots. Turbulent velocities derived from the curves of growth averaged 2.9 km/sec compared to 1.7 km/sec for the photosphere, while a line-profile analysis gave an average of 3.7 km/sec compared with 1.5 km/sec for the photosphere.

523.75 : 537.591.5

INFLUENCE OF MODULATION EFFECTS ON SOLAR FLARE RADIATION. See Abstr. 5862

523.75 : 551.594.12

IONIZATION OF THE UPPER ATMOSPHERE BY LOW-ENERGY CHARGED PARTICLES FROM A SOLAR FLARE. See Abstr. 6397

523.752

6461. A MODEL OF THE CHROMOSPHERE FROM MILLIMETER WAVE-LENGTH OBSERVATIONS. R.J.Coates.

Astrophys. J., Vol. 128, No. 1, 83-91 (July, 1958).

A new model of the chromosphere containing spicules was constructed from 8.6 and 4.3 mm wavelength data. In this model the spicules are cylindrical (1500 km in diameter) with their bases at the photosphere and their heights ranging from 3000 to 18 000 km. The number of spicules decreases rapidly with increasing height, and the spicules are distributed in angle about the predominant radial direction. The interspicule gas is hot, and the spicule gas is cool; the spicule temperature deduced from the millimeter wavelength observations is 6400°K.

523.752

6462. THE NUMBER OF SPICULES IN THE MIDDLE CHROMOSPHERE. R.G.Athay.

Astrophys. J., Vol. 129, No. 1, 164-71 (Jan., 1959).

Statistics are given for the number of Hα spicules observed at the solar limb for heights of 3000 km and above. The observed numbers are analysed to obtain the spatial distribution of spicules. It is found that at a height of 3000 km there are about 9.3×10^4 spicules on the sun and that these spicules cover about 0.6% of the solar surface.

523.752

6463. MOTIONS OF SOLAR PROMINENCES. I. ASCENDING POLAR FILAMENTS. M.Waldmeier.

Z. Astrophys., Vol. 44, No. 3, 213-20 (1958). In German.

The motions of a quasieruptive prominence in the polar region are investigated. Some of the knots are receding from the sun, others are falling down to the chromosphere. The maximum height is about 400 000 km, the largest velocity 380 km/sec. The accelerations deduced from the velocities are due to the sun's gravitation and to an unknown "prominence force". The latter is directed upwards in the higher regions of the trajectories and seems to have a centre around a region situated outside of the prominence at a height of about 60 000 km. The downward motions are governed by forces in the opposite direction of the motion or by attractions from this region. The accelerations from the "prominence force" are of the same order of magnitude as the gravitational accelerations.

523.755

6464. THE TOTAL SOLAR ECLIPSE AND CORONA OF 20 JUNE 1955. M.Waldmeier, H.Arber and H.Bachmann.
Z. Astrophys., Vol. 42, No. 3, 156-206 (1957). In German.

The corona observed at the eclipse of 20 June 1955 was of minimum-type, characterized by two long streamers in opposite directions, one in the NE-, the other in the SW-quadrant, which was in connection with disturbed photospheric regions near the sun's limb. In the new sunspot-cycle, the S-hemisphere is less developed than the N-hemisphere; therefore, the S-polar region shows the polar plumes still undisturbed, while the N-polar region is occupied by bright clouds with only few polar plumes visible. The inclination of these polar rays seems to be somewhat smaller than at the minimum eclipse of 1954. The index of the corona's shape, a + b, amounts to 0.24, as against 0.38 for the 1954 eclipse. A new definition for the phase of solar activity is used, based on the behaviour of the polar prominences; by this definition a better representation of the variation of a + b during the solar cycle has been reached. The ray of the K-component in the NE-quadrant can be followed up to a distance of at least r = 8. At larger distances it is replaced by a similar ray of the F-component situated exactly on the equator and visible up to r = 27. The ellipticity of the isophotes shows a minimum value at r = 3.6 and is increasing again at larger distances.

523.77

6465. EMISSION LINES IN THE EXTREME ULTRAVIOLET SPECTRUM OF THE SUN.
F.S.Johnson, H.H.Malitson, J.D.Purcell and R.Tousey.
Astrophys. J., Vol. 127, No. 1, 80-95 (Jan., 1958).

A solar spectrum, photographed from a rocket at 115 km altitude on 21 February 1955, shows 45 emission lines extending from 1892 to 977 A. Most of the lines have been identified. The lines of highest-excitation potential arise from O VI, N V, C IV, and Si IV. The Lyman-α line of hydrogen was present with an intensity of approximately 0.06 μW/cm^2, and its half-width was less than 0.3 A. Lyman-β was also photographed, as was the 1640.5 A line of He II. The continuum was followed to approximately 1550 A and shows strong continuous absorption below 2085 A. The O VI lines are slightly limb-brightened relative to Lyman-β; the same is true for the C IV resonance lines and the He II line at 1640.5 A, relative to lines of C I.

523.77

6466. ULTRAVIOLET EMISSION LINES IN THE SOLAR SPECTRUM. W.E.Behring, H.McAllister and W.A.Rense.
Astrophys. J., Vol. 127, No. 3, 676-9 (May, 1958).

Five spectrograms of solar ultraviolet radiation, taken from a rocket on 6 August 1957 led to information on wavelengths and half-widths of emission lines between 1032 and 1893 A in the solar spectrum. Identification of most of the emission lines with those previously observed was made. After allowance was made for instrumental broadening, the minimum half-widths of HL α and of the He II line at 1640.5 A, were established as 0.80 A and 0.30 A, respectively.

523.774

6467. INTENSITY OF THE CONTINUOUS SPECTRUM FROM THE CENTRE OF THE SOLAR DISK IN THE WAVELENGTH RANGE $3300 \leq \lambda \leq 6900$ A. D.Labs.
Z. Astrophys., Vol. 44, No. 1, 37-55 (1957). In German.

The continuum of the centre of the solar disk and a carbon-arc were compared spectrophotometrically. The results obtained were: (a) for $\lambda\lambda$ 3300 to 3700 A a distribution temperature of 6225°; (b) for $\lambda\lambda$ 3700 to 4950 A a distribution temperature of 7540°; (c) a Balmer discontinuity $\log I_{3700+} - \log I_{3700-} = D = 0.13$; (d) a depression of the energy distribution between $\lambda = 4950$ and 5550 A, and (e) at $\lambda = 5263$ A an absolute intensity $I_\lambda(0.0) = 43.8 \times 10^{13}$ erg · cm^{-2} · sec^{-1} ster^{-1} and $\Delta\lambda = 1$ cm.

523.821

6468. VISIBILITY OF STARS AT HIGH ALTITUDE IN DAYLIGHT. M.J.Koomen.
J. Opt. Soc. Amer., Vol. 49, No. 6, 626-9 (June, 1959).

The daylight visibility of stars was investigated for an observer altitude of 100 000 ft, using published visual threshold data and calculated sky luminance. Venus, Jupiter, and Sirius, plus Mars at its brighter phases, can be detected with the naked eye if the observer knows where to look for them in the sky. Saturn and Canopus may be seen only under rare circumstances. A random search of the sky will reveal neither planets nor stars except possibly Venus. If a 10-power telescope of large exit pupil is used, there is a possibility of detecting an occasional star by careful search of the sky. The daytime sky will not exhibit night-time luminance until an altitude of roughly 100 km has been reached, assuming no contribution from airglow.

523.852 : 532.5 : 538.3

MAGNETIC INFLUENCES ON THE STABILITY OF SPIRAL NEBULAE. See Abstr. 5959

523.877

6469. STELLAR CONFIGURATION WITH A TOROIDAL MAGNETIC FIELD. J.De.
Z. Astrophys., Vol. 44, No. 4, 249-54 (1958).

The results of a previous paper (Abstr. 7108/1956) concerning the equilibrium form of a stellar body under the action of a toroidal magnetic field due to a current distribution inside the body, are extended to the case of bodies with differential rotation about the axis. The case of rigid rotation is completely evaluated. The propagation of a type of Alfvén wave in a non-uniform field is also investigated.

525.3

6470. EFFECT OF THE EARTH'S MAGNETIC FIELD ON THE MOTION OF AN ARTIFICIAL SATELLITE. O.Jefimenko.
Amer. J. Phys., Vol. 27, No. 5, 344-8 (May, 1959).

The effect when moving in a circular orbit in the plane of the magnetic equator of the earth is discussed. Approximate formulae for the current induced in the satellite and for the resulting induction drag are obtained. The current in a conducting satellite of an average size at an altitude of several hundred kilometers is estimated to be of the order of milliamperes. The induction drag may exceed the friction drag for satellites of large dimensions and for elongated satellites.

525.3

6471. MOTION OF A SATELLITE AROUND AN UNSYMMETRICAL CENTRAL BODY. R.R.Newton.
J. appl. Phys., Vol. 30, No. 1, 115-17 (Jan., 1959).

If a central body does not have an inversion centre, the eccentricity of a satellite orbit varies periodically, with low frequency and large amplitude. Thus, unless the satellite is initially in a large enough orbit, it may strike the central body, even in the absence of dissipative forces. Details are worked out for a central body composed of a large spherical mass and a small point mass contained somewhere within it. Application is made to satellites of the moon.

525.3 : 551.510.3

6472. TWO ATMOSPHERIC EFFECTS IN THE ORBITAL ACCELERATION OF ARTIFICIAL SATELLITES. L.G.Jacchia.
Nature (London), Vol. 183, 526-7 (Feb. 21, 1959).

The oscillations in the orbital acceleration of satellites 1958 δ1 and 1958 β2, are found to be in phase and have a period of 29 days. For these satellites and 1958 β1, a relation has been found between the orbital acceleration and the angular distance of the perigee from the sub-solar point. It is suggested that both effects are the result of solar radiation. H.J.A.Chivers

525.3 : 551.510.3

6473. IRREGULARITIES IN THE DENSITY OF THE UPPER ATMOSPHERE: RESULTS FROM SATELLITES.
D.G.King-Hele and D.M.C.Walker.
Nature (London), Vol. 183, 527-9 (Feb. 21, 1959).

An oscillation with a period of about 28 days has been found in the rate of change of the orbital period of artificial satellites. This is ascribed to changes in air density due to solar disturbances. (See also preceding abstract). H.J.A.Chivers

525.3

6474. RECORDING RADIO SIGNALS FROM EARTH SATELLITES. G.H.Munro and L.H.Heisler.
Nature (London), Vol. 183, 809-10 (March 21, 1959).

A brief description is given of a simple equipment to measure intensity variations and make simultaneous Doppler frequency shift measurements on the radio transmissions from an artificial earth satellite. These measurements have been used to compute the velocity and height of the satellite 1958 $\delta 2$ (Sputnik III) which has been consistently observed for several months. C.Hazard

525.3

6475. A NEW VALUE FOR THE EARTH'S FLATTENING, DERIVED FROM MEASUREMENTS OF SATELLITE ORBITS. D.G.King-Hele and R.H.Merson.
Nature (London), Vol. 183, 881-2 (March 28, 1959).

The calculated flattening derived from observations of the orbital motion of satellite 1957 β depended on an assumed value for a coefficient D in the fourth harmonic of the Earth's gravitational potential. The value of D is now derived from the observations of the rate of rotation of the orbital planes of satellites 1957 β and 1958 $\beta 2$. The revised value of the flattening is 1/298.2. R.A.Newing

529.786 : 538.561 : 621.317.36

6476. CONSTRUCTION AND MODE OF OPERATION OF A MICROWAVE FREQUENCY STANDARD. H.J.Köhler.
Exper. Tech. der Phys., Vol. 5, No. 3, 108-16 (1957). In German.

The output of a 10 Mc/s quartz controlled oscillator with thermostat is compared with the Rugby standard signal and fed to a chain of multiplier stages incorporating a butterfly circuit at 180-540 Mc/s and subsequent crystal multipliers, as well as a mixer stage to which the output of a 3 cm klystron is also connected. An accuracy of 2×10^{-6} is obtained at 16 mm, which is measured by means of a Stark spectrometer with reference to the (9.6) ammonia line. H.Motz

529.786 : 531.711 : 535.33

ATOMIC STANDARDS OF LENGTH AND TIME.
See Abstr. 5492

PHYSICS

GENERAL

53

6477. GRADUATE SCHOOLS FOR PHYSICISTS. R.I.Weller.
Amer. J. Phys., Vol. 27, No. 5, 307-10 (May, 1959).

Factors affecting the choice of graduate schools are outlined. A quantitative ranking of graduate schools offering doctoral programmes in physics is presented.

53

6478. NOTE ON THE DUAL NATURES OF LIGHT AND OF MATTER. E.Ikenberry.
Amer. J. Phys., Vol. 27, No. 5, 359-60 (May, 1959).

L. de Broglie's heuristic interpretation of the equations $E = h\nu$, $p = h/\lambda$ is applied in deriving Planck's radiation law and to the Schrödinger and Dirac equations.

53.081.7 : 669

6479. URANIUM DATA MANUAL. Compiled by E.L.Francis.
United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley. Report IGR-R/R-287 (1958) 49 pp. Obtainable from H.M. Stationery Office.

A compilation of data on the physical, mechanical and chemical properties of uranium and its more important alloys, and the effects of irradiation and thermal cycling on these properties. A list of the references cited is appended.

53.081.7 : 69

6480. THORIUM DATA MANUAL. Compiled by E.L.Francis.
United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley. Report IGR-R/R-303 (1958) 22 pp. Obtainable from H.M. Stationery Office.

This manual is a compilation of data on the physical, mechanical, chemical and irradiation properties of thorium. A list of the references cited is appended.

53.081.7 : 669

6481. NIOBIUM DATA MANUAL. Compiled by E.L.Francis.
United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley. Report IGR-R/R-304 (1958) 15 pp. Obtainable from H.M. Stationery Office.

A compilation of data on the physical, mechanical and chemical properties of niobium. A list of the references cited is appended.

53.081.7 : 669

6482. VANADIUM DATA MANUAL. Compiled by E.L.Francis.
United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley. Report IGR-R/R-306 (1958) 14 pp. Obtainable from H.M. Stationery Office.

A compilation of data on the physical, mechanical and chemical properties of vanadium. A list of the references cited is appended.

530.1

6483. ON THE CONCEPTUAL NECESSITY AND USE OF PERFECT COUPLERS IN SCHEMATIC DIAGRAMS. H.M.Trent.
J. Acoust. Soc. Amer., Vol. 31, No. 3, 326-32 (March, 1959).

If the criterion is adopted that a schematic diagram of a system must give a complete representation of all the physical or engineering principles involved including a specification of the characteristics of each part and how the various parts are joined to form the system, it follows that perfect couplers must be included in the list of items available to anyone creating schematic diagrams. It is shown by examples that perfect couplers produce their action by the imposition of constraints and that the set of constraints for a given coupler imposes the condition of no power loss or gain. Conversely, if a conceptual device is known to be a perfect coupler and some constaints are known, then the remaining ones can be deduced. It is shown that perfect couplers may be of two types and that examples of each type are common. It is further pointed out that perfect couplers present no problem if an investigator is always aware of their possible existence. The discussion closes by showing that couplers can be dealt with mathematically in a systematic manner.

530.11 : 535.1

6484. A PROPOSED ASTRONOMICAL TEST OF THE "BALLISTIC" THEORY OF LIGHT EMISSION. H.Dingle.
Monthly Not. Roy. Astron. Soc., Vol. 119, No. 1, 67-71 (1959).

Ritz's "ballistic" theory of light emission is outlined, and the evidence on which it has been regarded as untenable is re-examined. It is shown that the theory as presented by Ritz is indefinite, and that, when it is amended to a form consistent with the postulate of relativity of motion, it is no longer vulnerable to the earlier criticisms. The question of its admissibility is therefore open. It is pointed out that determinations of the "constant of aberration" from observations of distant nebulae might settle this question, and such determinations are recommended.

GRAVITATION . RELATIVITY

530.12

6485. ON THE PHYSICAL SIGNIFICANCE OF THE RIEMANN TENSOR. F.A.E.Pirani.
Acta phys. Polon., Vol. 15, No. 6, 389-405 (1956).

Some of the difficulties of interpretation of general relativity theory can be avoided by employing the tetrad formalism. The timelike vector of any tetrad is identified physically with the velocity vector of an observer, the spacelike vectors with the directions of local Cartesian coordinate axes used by the observer. It is found that the Newtonian concept of nonrotation is represented most closely if the spacelike vectors undergo Fermi propagation along the observer's world-line. The behaviour of free particles is investigated by referring to tetrads the equation of geodesic deviation, which provides an immediate physical interpretation for the Riemann tensor. A simple model of a gyroscope is constructed by modifying Papapetrou's equations of a spinning test particle. The behaviour of this model supports the interpretation of Fermi propagation. The interpretation is developed by investigating the discontinuity in the Riemann tensor across the boundary of a world-tube of matter, using Lichnerowicz's conditions.

530.12

6486. THE EQUATIONS OF MOTION OF CHARGED PARTICLES IN GENERAL RELATIVITY. S.Bażański.
Acta phys. Polon., Vol. 15, No. 6, 363-79 (1956).

530.12

6487. THE EQUATIONS OF MOTION IN GENERAL RELATIVITY THEORY AND THE ACTION PRINCIPLE. L.Infeld.
Acta phys. Polon., Vol. 16, No. 3, 177-210 (1957).

Deals with the formulation of the equations of motion for p bodies, assuming (1) the field equations of General Relativity Theory; (2) the fact that the energy—momentum tensor is different from zero only along certain world lines, which means that this tensor depends linearly on Dirac's δ-functions. It can be shown that from these simple assumptions the proper Lagrangian can be found almost without tedious calculation. It will give the equations of motion up to the post-Newtonian order. Also the connection between these equations and those of the "geodetic lines" is elucidated.

530.12

6488. RELATIVISTIC MECHANICS OF A PARTICLE. D.Park.
Amer. J. Phys., Vol. 27, No. 5, 311-13 (May, 1959).

The dynamics of a particle in special relativity can be developed in a form analogous to that of Newtonian mechanics. One starts with the observation that the four-vector generalization of the Newtonian momentum and the Lorentz transformation are two complementary but equivalent means for describing the behaviour of a body in motion. This suffices to determine the four-vector unambiguously, and the laws of dynamics are conveniently expressed by the assertion that this vector satisfied a conservation law. Whether or not a particle's rest mass is conserved in an interaction is undecided by this principle, but is shown to be determined by the nature of the interaction involved.

530.12

6489. SPINOR THEORY AND RELATIVITY. II.
W.T.Payne.
Amer. J. Phys., Vol. 27, No. 5, 318-28 (May, 1959).

For Pt I, see Abstr. 48(1956). The various kinds of second-rank spinors are defined; geometric representations are given for two special cases; and the applications of spinor theory to relativistic quantum mechanics and to electromagnetic theory are studied.

530.12

6490. A METHOD OF QUANTIZATION IN FIVE DIMENSIONAL UNIFIED [FIELD] THEORY. P.Droz-Vincent.
C.R.Acad. Sci. (Paris), Vol. 248, No. 12, 1790-2 (March 23, 1959).
In French.

Lichnerowicz' procedure (Abstr. 1019/1959) is generalized by defining the combined gravitational and electromagnetic fields in terms of a tensor $H_{\alpha\beta,\lambda\mu}$ in a Minkowski 5-space with signature (- - - - +). R.A.Newing

530.12

6491. THE GRAVITATIONAL RADIATION OF A TEMPORARILY NON-STATIONARY SYSTEM.
D.Geissler, A.Papapetrou and H.Treder.
Ann. Phys. (Leipzig), Folge 7, Vol. 2, No. 7-8, 344-50 (1959).
In German.

The total energy radiated from a system which has a periodic time-variation of finite duration is calculated in a covariant manner, and is found to be non-zero independently of the choice of coordinate system. It is concluded that such radiation represents a real physical process. R.A.Newing

530.12

6492. SOLUTION OF THE HUND GRAVITATIONAL EQUATIONS.
Ll.G.Chambers.
Canad. J. Phys., Vol. 37, No. 4, 433-7 (April, 1959).

Solutions are indicated for the Maxwell-type gravitational field equations developed by Hund (1948) in the realization of Mach's programme. These solutions are of interest in connection with recent work by Kaempffer (1958).

530.12 : 525.3

6493. VERIFICATION OF GENERAL RELATIVITY BY MEANS OF ARTIFICIAL PLANETS. J.J.Gilvarry.
Nature (London), Vol. 183, 666-7 (March 7, 1959).

The controllable orbit of an artificial planet can be selected to yield a very large relativity advance of perihelion under certain conditions. Since a significantly large advance is possible only for large eccentricity, this requires (if the aphelion point is not within the Earth's orbit) that $2a - q \geq 1$, where a = semi-major axis and q = perihelion distance of the planet's orbit from the Sun's centre. Finally, to optimize the number of passages in which observation is possible, it is required that $a \sim (n/m)^{2/3}$, where n and m are small integers. J.K.Skwirzynski

530.12

6494. ON THE MOTION OF ROTATING SATELLITES AND BINARY STARS ACCORDING TO EINSTEIN'S THEORY OF GRAVITATION. N.S.Kalitzin.
Nuovo Cimento, Vol. 11, No. 2, 178-85 (Jan. 16, 1959). In German.

The problem of the apsidal motion of two rotating bodies of comparable mass is treated according to Einstein's theory of gravitation in second approximation using the equations of motion of Fock. The formula obtained for the revolution of the apsides is given by the sum of three terms, the first and second of which represent the Einstein and the Lense—Thirring effects. The third term represents a new additional rotation which is proportional to the sum of the products of the intrinsic angular momentum of one of the bodies and the mass of the other. T.R.Carson

530.12

6495. GRAVITATIONAL MOTION AND RADIATION. I.
A.Peres.
Nuovo Cimento, Vol. 11, No. 5, 617-27 (March 1, 1959).

A method is established for solving Einstein's equations by successive approximations, uniqueness and compatibility at each step being secured by imposing de Donder's condition on the field. This turns out to restrict the freedom of choice of the sources in a way that determines their laws of motion, directly from the field quantities, without any use of integration around singularities. If the approximation parameter is the reciprocal velocity of light, the first non trivial approximation results in the constancy of the rest mass, and in Newton's law of attraction. The next step shows that there is no first-order correction to these laws. The third approximation then gives a small correction to the rest mass, which is found to be increased by the presence of other bodies. There is also a second-order correction to the acceleration (not explicitly evaluated here) which causes the perihelion advance in the two-body problem. The fourth approximation involves a contribution from the radiation field. It is found that in order to fulfil de Donder's condition, one must introduce into the field a term which is linear in the sources, although it does not appear in the so-called "linear approximation". This result may cast some doubts on the validity of the latter.

530.12

6496. GRAVITATIONAL MOTION AND RADIATION. II.
A.Peres.
Nuovo Cimento, Vol. 11, No. 5, 644-55 (March 1, 1959).

General relativistic laws of motion for slow particles are deduced from successive approximate solutions of Einstein's equations, subject to de Donder's conditions. The first three approximations give results identical with those of Pt I (Newtonian and post-Newtonian equations of motion). Higher approximations involve contributions from the radiation field. It is found that they can be treated independently of other relativistic effects, and cause fifth-order corrections to the rest-masses and accelerations of the particles. In particular, it is shown that as a consequence of gravitational radiation, a system of particles gains energy, thus implying that gravitational waves carry away a negative amount of energy. This is made plausible by showing that the energy density of the gravitational field is also a negative quantity. An electromagnetic analogy of these results is proposed.

530.12

6497. QUADRATIC LAGRANGIANS AND GENERAL RELATIVITY.
P.W.Higgs.
Nuovo Cimento, Vol. 11, No. 6, 816-20 (March 16, 1959).

Two out of the three sets of field equations associated with Lagrangians quadratic in the Riemann—Christoffel tensor, which were recently discussed by Stephenson, are shown to be equivalent to the source-free Einstein equations with an arbitrary "cosmological" term.

530.12

6498. LAGRANGIAN FOR A FREE RELATIVISTIC FLUID MASS. F.Halbwachs and J.P.Vigier.
C.R.Acad. Sci. (Paris), Vol. 248, No. 8, 1124-6 (Feb. 23, 1959). In French.

The Lagrangian defines the motion of the Bohm—Vigier rotating fluid droplet. R.A.Newing

530.12

6499. STUDY OF THE WORLD VELOCITY AT EACH POINT OF A RELATIVISTIC ROTATING FLUID MASS. M.Kléman.
C.R. Acad. Sci. (Paris), Vol. 248, No. 8, 1126-9 (Feb. 23, 1959). In French.

The motion of a fluid mass is represented as a relativistic analogue of translation and rotation about the mass centre together with a fluid deformation. R.A.Newing

530.12 : 532.5

6500. RELATIVISTIC HYDRODYNAMICS FOR A CHARGED NONVISCOUS FLUID. C.C.Wei.
Phys. Rev., Vol. 113, No. 6, 1414 (March 15, 1959).

The equations of relativistic hydrodynamics are derived from an alternative variational method and a generalized vorticity equation is obtained.

530.12

6501. KINEMATIC RELATIVITY AND THE OPERATIONAL FORMULATION OF A LORENTZ INVARIANT DYNAMICS. W.S.Krogdahl.
Z. Astrophys., Vol. 42, No. 1, 48-65 (1957).

Some of the objections which have been brought against the original formulation of kinematic relativity may be removed by an operational, inductive formulation of Lorentz invariant dynamics. The theory is also capable of yielding the standard results for the advance of Mercury's perihelion and the bending of light rays at the limb of the sun. At the same time, it avoids some of the objections that may be made of the theory of general relativity.

FIELD THEORY . QUANTUM THEORY

530.145

6502. AN EXAMPLE OF A FIELD THEORY WITH INDEFINITE METRIC IN HILBERT SPACE. I. M.Markov.
Nuclear Phys., Vol. 10, No. 2, 140-50 (Feb. (2), 1959).

A field theory is considered in which the Green's functions have singularities not on a cone but on a hyperboloid. The metric of the corresponding Hilbert space is indefinite. Equations of motion for the boson and fermion fields are derived. The theory goes over to the usual field theory when a certain constant (characteristic length) approaches zero. The ultimate aim of the investigation is an attempt to find a possible reasonable interpretation of the negative energy density of the boson fields, of the negative probabilities, and of other similar features which appear in the theory, by appropriately modifying the concept of a particle coordinate so as to obtain the proposed progagation functions.

530.145 : 530.162

6503. DERIVATION OF THE GIBBS POTENTIAL OF A SYSTEM CONSISTING OF A LARGE NUMBER OF PARTICLES. II. C.Bloch and C.De Dominicis.
Nuclear Phys., Vol. 10, No. 2, 181-96 (Feb. (2), 1959). In French.

For previous Part, see Abstr. 7701 (1958). The expansion of the Gibbs potential in powers of the activity is derived with the use of the second quantization, re-establishing a result of Ward and Montroll and the link with the classical Ursell—Yvon—Mayer expansion. Partial summation of non-interacting "loops" leads to the expansion established in a previous paper. This expansion can be cast into a form in which a "reduced potential", temperature and activity dependent, replaces the usual interaction. All contributions are then given by the (connected) "irreducible" diagrams only.

530.145 : 539.163

BETA—GAMMA CORRELATION AND TIME-REVERSAL INVARIANCE. See Abstr. 6066

530.145

6504. INTRODUCTION OF A NEUTRAL PSEUDOSCALAR FIELD AND A POSSIBLE CONNECTION BETWEEN STRANGENESS AND PARITY. K.Nishijima.
Nuovo Cimento, Vol. 11, No. 5, 698-710 (March 1, 1959).

A neutral pseudoscalar field with vanishing rest mass is introduced, first asking for the condition guaranteeing the vanishing rest mass, which turns out to be an invariance requirement under a certain kind of gauge transformation. Then assigning an appropriate transformation to each field one can restrict the possible forms of weak interactions. The main results obtained in this paper are as follows: (1) the change of strangeness necessarily requires the violation of both parity and charge conjugation; (2) the change of the number of electrons or of muons necessarily violates parity and charge conjugation; (3) strangeness can change only by unity in weak interactions.

530.145

6505. EXTENDED INVARIANCE PROPERTIES OF QUANTUM FIELDS. I. LAGRANGIAN FORMALISM. M.E.Mayer.
Nuovo Cimento, Vol. 11, No. 6, 760-70 (March 16, 1959).

This is the first paper from a series in which the consequences of invariance of quantum field theory under an f-parameter Lie group are investigated. It deals with the consequences of invariance of a general Lagrangian under such a group. It is shown that the invariance leads to the conservation of f "current density operators", the corresponding charge operators being a representation of the Lie group on the state vector space. Invariance under extended transformations, i.e. transformations in which the parameters are functions of the space-time point leads to the necessity of introducing f non-commuting vectors fields. The general structure of the Lagrangian corresponding to these fields is established and their possible physical counterparts are discussed.

530.145

6506. A DISCUSSION ON BILOCALITY. II. J.Rayski.
Acta phys. Polon., Vol. 15, No. 6, 407-21 (1956).

For previous part, see Abstr. 7952 (1956). Two versions of bilocal field theory are discussed, one of them leading to a rotator model of elementary particles in the usual space, the other to a rotator model in the isotopic spin space. It would seem that a simultaneous consideration of both generalizations, leading to a classification of particles according to spin and isospin, is most promising. The higher states of mass appear to be connected with rotations in the isospace, rather than in the usual space.

530.145

6507. FREE FIELD OPERATORS AND THE YANG—FELDMAN FORMALISM. K.L.Nagy.
Acta phys. Hungar., Vol. 9, No. 3, 269-74 (1959).

Schweber's (Abstr. 9434/1955) and Polkinghorne's (Abstr. 4747/1958) calculations are simplified and, to some extent, generalized. Free fields having commutation relations in which the interaction effect is contained are defined. These fields are connected with the matrix elements of $U[\sigma',\sigma]$.

530.145

6508. THE FUNDAMENTAL THEOREM OF CONTINUOUS TRANSFORMATIONS IN THE QUANTUM THEORY. G.Marx.
Acta phys. Hungar., Vol. 9, No. 4, 393-402 (1959).

The unitary operator, the generator of symmetry transformations in the Hilbert-space, is formed on the basis of the field equations, together with the commutation law. This method is the reverse of Schwinger's (Abstr. 6731/1951) used in the covariant formulation of the quantum theory, and eliminates some insufficiencies of previous treatments.

530.145

6509. SOME NEW CONSERVATION LAWS. D.Finkelstein and C.W.Misner.
Ann. Phys. (New York), Vol. 6, No. 3, 230-43 (March, 1959).

It is shown that field theories possessing a certain type of nonlinearity, termed intrinsic, also possess a new type of conservation law in which the conserved quantity is an integer even in the unquantized theory. For the example of general relativity, the conserved quantity is shown to assume the values $M = 0, \pm 1, \pm 2, \cdots$. This conservation law ("conservation of metricity") is valid regardless of any interaction of the metric field with other fields and regardless even of the equation of motion assumed for the metric field itself. The basis of the work is the principle that a quantity which is unchanged in value by an arbitrary continuous deformation is a fortiori unchanged in value by the passage of time. Some properties of metricity and of its carrier are given.

530.145

6510. ANALYTICITY OF WIGHTMAN FUNCTIONS AT COMPLETELY SPACE-LIKE POINTS.

D.Ruelle.

Helv. phys. Acta, Vol. 32, No. 2, 135-7 (1959).

See Abstr. 901/1956.

530.145

6511. ASYMPTOTIC CONDITIONS IN QUANTUM FIELD THEORIES.

G.F.Dell'Antonio and P.Guimanelli.

Nuovo Cimento, Vol. 12, No. 1, 38-53 (April 1, 1959).

On the ground of quite general hypotheses, such as Lorentz invariance of the theory and causality, and restricting to the case in which no zero-mass particles occur, it is proved that it is possible to define in the ordinary field theory "asymptotic states" according to Haag. The proof is mainly based on the integral representations of the generalized singular functions.

530.145

6512. $\hbar$-QUANTIZATION OF THE FREE, BILOCAL BOSON FIELD.

G.Pócsik.

Acta phys. Hungar., Vol. 9, No. 3, 261-7 (1959).

The relation between Rayski's systematization theory of elementary particles and the higher-spin theory of Fierz offers a possibility for the h-quantization of the free, bilocal boson field. A relativistic invariant D-function is introduced, and its properties are dealt with. The problems arising when isospaces are taken into consideration are discussed.

530.145

6513. IMPLICATIONS OF PARITY NONCONSERVATION AND TIME REVERSAL NONINVARIANCE IN ELECTROMAGNETIC INTERACTIONS.

M.Sachs.

Ann. Phys. (New York), Vol. 6, No. 3, 244-60 (March, 1959).

The requirement of the relativistic invariance of physical phenomena is expressed mathematically by requiring an invariance under the transformations of the proper Lorentz group. Included in the class of interactions which would satisfy this requirement are those which are odd with respect to space reflections and time reversal, and therefore violate both parity conservation and time reversal invariance. This property is exploited in the construction of a theory which sacrifices P and T invariance for symmetry in the electric and magnetic field variables in electromagnetic interactions with charged spin one-half particles. The theory is constructed by generalizing the electromagnetic four-potential so as to include a pseudovector part as well as a vector part. Due to the modification of the interaction Lagrangian by the pseudovector potential, an extra pseudovector force is introduced from the equations of motion, which effectively reverses the roles of the electric and magnetic field variables in the normal vector Lorentz force. A qualitative discussion of atomic spectra is given in the light of the present theory. A dimensionless number ξ which multiplies the pseudovector potential and is a measure of the amount of violation of P and T in electromagnetic interaction is found to be less than 10^{-13} to insure compatibility with experimental data. It is pointed out that the effects of this theory are optimized when applied to bound state systems which are subjected to electric fields which lack an inversion centre. A few experiments utilizing this result are proposed.

530.145

6514. THE SUPPLEMENTARY CONDITION IN QUANTUM ELECTRODYNAMICS.

D.J.Candlin.

Nuovo Cimento, Vol. 12, No. 1, 54-62 (April 1, 1959).

The difficulties of the supplementary condition are completely analogous to those of the momentum of the centre of mass in non-relativistic bound-state problems. It is unnecessary to introduce an indefinite metric or limiting procedures.

530.145 : 539.12

6515. RADIATIVE CORRECTIONS TO BREMSSTRAHLUNG.

A.N.Mitra, P.Narayanaswamy and L.K.Pande.

Nuclear Phys., Vol. 10, No. 6, 629-53 (May (1), 1959).

The second-order radiative corrections to bremsstrahlung are evaluated by a straightforward application of Feynman—Dyson techniques, taking all the possible effects into account. The results are given in simplified forms for certain relativistic and extreme relativistic regions discussed in the text. The cross-section for double bremsstrahlung are also evaluated in various limits, in order to cancel out the "infrared" terms appearing in the second-order corrections. The present result for the extreme relativistic limit seems to disagree with one recently obtained by Fomin (Abstr. 8206/1958), using "mass operator" techniques.

530.145

6516. SYMMETRIES OF LEPTONIC INTERACTIONS.

I.Saavedra.

Nuclear Phys., Vol. 10, No. 1, 6-19 (Feb. (1); 1959).

It is proved that leptonic processes can be described in isospace by using spinor representations of the rotation group, and that the procedure is consistent with the general formalism and with the experimental data.

530.145

6517. ON THE NUMBER OF FUNDAMENTAL FIELDS.

W.Thirring.

Nuclear Phys., Vol. 10, No. 2, 97-106 (Feb. (2), 1959).

An investigation of the number of fundamental fields needed to obtain the internal constants of the motion for strong interactions. With three massless Majorana fields, one obtains all additive constants, but to get also the multiplicative constants one has to double the number of fields. It is demonstrated that the three-field case can be excluded because of the accuracy with which parity conservation is known for strong interactions. The consequences of a γ_5-invariance are studied for the 6-field case. It is shown that in this case either all baryons have mass zero or one gets twice the empirical number of baryons. Furthermore, one finds that in this case the vector and the axial vector currents of the strangeness conserving β-interaction are conserved.

530.145

6518. THE RENORMALIZABILITY OF VECTOR MESON INTERACTIONS.

S.L.Glashow.

Nuclear Phys., Vol. 10, No. 2, 107-17 (Feb. (2), 1959).

A new and less restrictive criterion is deduced for the renormalizability of vector meson interactions. As an example, the electromagnetic interaction of a charged vector meson with unit anomalous magnetic moment is shown to be renormalizable. In order to construct a renormalizable theory of the elementary-particle decays in which such a particle plays the role of an intermediary, it is found necessary to assume an intimate connection between decay-inducing and electrodynamic interactions.

530.145

6519. SYMMETRY LAWS AND STRONG INTERACTIONS.

J.S.Sakurai.

Phys. Rev., Vol. 113, No. 6, 1679-92 (March 15, 1959).

An attempt is made to explore the possible connection between the symmetry laws in internal space (e.g., isospin space) and in Lorentz space, with special attention to the reason why strong interactions are parity-conserving. For direct (nonderivative-type) pion-nucleon interactions, CP invariance and charge independence are sufficient to guarantee the separate conservation of P and C, as previously pointed out. For derivative-type pion—nucleon interactions, charge independence and G invariance (rotational and inversion invariance in three-dimensional isospin space) require that parity (and CP) be conserved; in addition we can also show that the charge-triplet pion must be pseudoscalar, provided that the virtual Yukawa process $\pi^0 \rightleftharpoons p + \bar{p}$ is allowed or, equivalently, the π^0 can be regarded as a bound state of a proton and an antiproton as far as symmetry laws are concerned. For the K couplings, analogous conditions cannot be obtained from the usual assumption of charge independence alone. However, if the K couplings (rather than the π couplings) exhibit a higher internal symmetry in the sense that the K couplings are universal, the high K symmetry plus charge independence in the usual sense imply parity conservation both in the case of CP-invariant nonderivative-type K interactions and in the case of G-invariant derivative-type K interactions. The high K symmetry also implies that the relative NΞ parity as well as the relative $\Lambda\Sigma$ parity is even. It is conjectured that, if the K couplings must be of a derivative type, only ps—pv coupling is allowed, which means that the K particle is pseudoscalar. The global symmetry model, which cannot be reconciled with the assumption of the high K symmetry, is re-examined. The high K symmetry is destroyed in a specific and definite manner by the π couplings, and relations among the various coupling constants are inferred from the baryon mass spectrum. Some empirical implications of the model are discussed. Whereas G invariance requires the symmetric appearance of the two chiral spinor $\frac{1}{2}(1 + \gamma_5)\psi$ and $\frac{1}{2}(1 - \gamma_5)\psi$ for strangeness-conserving processes, for strangeness nonconserving processes G conjugation carries charge-conserving interactions into inadmissible interactions that do not conserve electric charge. Hence, if one takes the point of view that parity-conserving interactions are generated by G conjugation, one has some understanding of the puzzling fact that strangeness conservation and parity conservation have the same domain of validity. Further theoretical speculations are made.

530.145

6520. GREEN'S FUNCTION FOR THE DIRAC EQUATION.
L.Hanke and P.Urban.
Acta phys. Austriaca, Vol. 12, No. 3, 304-14 (1959). In German.

Expressions for the Green's function for the Dirac equation in the presence of a homogeneous magnetic field of infinite extent. It is evaluated in both coordinate and momentum space, in the former case as a series expansion. T.R.Carson

530.145

6521. ON A SCREW MODEL OF [HOT] PARTICLES IN ISO-SPACE.
J.Rayski.
Acta phys. Polon., Vol. 16, No. 4, 279-91 (1957).

This investigation facilitates the physical interpretation of charge, isobaric spin, attribute (strangeness), and mass in terms of rotations in isospace. This model possesses some analogies with the hydrogen atom: the particle has a spinning centre, a spinning outer point, an orbital angular momentum, and a size. The particle (antiparticle) possesses also a property of a right (left) screw. The spin of the centre is interpreted as isobaric spin. Strangeness is replaced by a more physical attribute being an extremum component of the angular momentum of the outer point. This angular momentum together with the radius of the particle, determines the rest mass. A privileged "third axis" is no more a property of isospace but of the particle itself. The algebraic additivity of the attributes is secured by means of a generalized postulate of contact interaction. Conservation of the total angular isomomentum holds for strong as well as for weak interactions between hot particles. A new "particle" — isotrino — is suggested.

530.145

6522. KLEIN PARADOX FOR THE KLEIN—GORDON EQUATION.
R.G.Winter.
Amer. J. Phys., Vol. 27, No. 5, 355-8 (May, 1959).

The behaviour of a beam of spin-zero particles incident on a region of large potential increase is examined. The results are compared with those obtained from similar computations employing the Dirac equation. This comparison yields an instructive illustration of the difference between particles and antiparticles in spin-zero and spin one-half single-particle theory.

530.145

6523. SPECTRAL FUNCTIONS IN THE STATIC THEORY.
J.D.Walecka.
Nuovo Cimento, Vol. 11, No. 6, 821-36 (March 16, 1959).

The spectral functions of the electromagnetic form factors of the nucleon are discussed within the framework of the static theory. 1/M recoil corrections are also included and it is shown that these corrections are close to those given by dispersion theory and that they profoundly alter the spectral functions indicating that the application of the static model to this problem is of doubtful validity.

530.145

6524. REPRESENTATIONS OF THE DIRAC EQUATION.
S.K.Bose, A.Gamba and E.C.G.Sudarshan.
Phys. Rev., Vol. 113, No. 6, 1661-3 (March 15, 1959).

A representation is discussed which displays the equations extreme relativistic properties. The "spin" appears naturally related to the "position".

530.145 : 539.17

RELATIVISTIC K-SHELL PHOTOEFFECT. See Abstr. 5056

530.145

6525. SELF AND EXTERNAL MESON FIELDS. R.T.Sharp.
Canad. J. Phys., Vol. 37, No. 4, 515-20 (April, 1959).

Instead of a single (isotopic vector) field to describe pions, it is sometimes advantageous to introduce several such fields with identical properties except for their coupling to the sources of the field (the baryons). In this way one can formally distinguish between self pions (roughly, those which can be emitted and absorbed by the same baryon) and external pions (roughly, those which are only exchanged between baryons or emitted into or absorbed from free states). K-mesons can be treated similarly. The device, which is of general applicability, simplifies many derivations and calculations in quantum field theory. As an illustration of the method it is used to derive the Low equations for scattering of pions and K-mesons by nucleons and for associated production. A suggestion is made for treating the nucleon—nucleon interaction.

530.145

6526. THEORY OF THE SCATTERING OPERATOR. J.M.Jauch.
Helv. phys. Acta, Vol. 31, No. 2, 127-58 (1958).

Gives a complete theory of the scattering operator on a rigorous mathematical foundation for a certain class of quantum mechanical systems called, "simple scattering systems". These systems are characterized by three properties. The relation of these properties to the physical content of scattering is explained. The wave operator and the scattering operator are defined and their existence is proved with mathematically rigorous methods. No assumptions are needed regarding the occurrence of bound states and the location of their energy with respect to the continuum region of the total energy operator. The existence is demonstrated of a certain integral representation of the scattering operator which has often been used as a starting point of the iteration approximation. Certain general properties of scattering systems are obtained. This leads to necessary conditions for systems to be scattering systems as well as to a new definition of the scattering operator. The scattering cross-section is defined from the scattering operator. The improvement of this derivation over the older ones consists in the special care employed for stating the assumptions which must go into such a derivation and the avoidance of improper functions or other artificial devices.

530.145

6527. THEORY OF THE SCATTERING OPERATOR. II. MULTICHANNEL SCATTERING. J.M.Jauch.
Helv. phys. Acta, Vol. 31, No. 7, 661-84 (1958).

The mathematical theory of the scattering operator is developed for the general scattering systems involving an arbitrary number of channels. It includes as a special case the theory for "simple scattering systems" given in an earlier paper (see preceding abstract). The scattering system is defined as a quantum mechanical system which satisfies certain asymptotic and completeness conditions. The existence of the S-operator, as well as its unitary property, is then a rigorous mathematical consequence of this property. A crucial step in these deductions is the orthogonality theorem for the left projections of the wave operators, which is proved. The various ways are discussed of introducing the "in" and "out" operators and their relation to the S-operator.

530.145

6528. POTENTIAL ENERGY MATRIX ELEMENTS BETWEEN NON-OVERLAPPING WAVE FUNCTIONS. N.Bernardes.
Nuovo Cimento, Vol. 11, No. 5, 628-34 (March 1, 1959).

Matrix elements of the potential energy of interaction are calculated for the case of two spherically symmetric, localized and non-overlapping wave-functions. The result is expressed as a power series, and is applicable to a wide class of central force potential energies, and non-overlapping wave-functions. As an illustration, a discussion is given of the diagonal matrix elements of the potential energy corresponding to a Van der Waals law of force.

530.145

6529. ON THE INTERACTION HAMILTONIAN OF SYMMETRIC PSEUDOSCALAR MESON THEORY. V.Singh.
Nuovo Cimento, Vol. 11, No. 6, 800-4 (March 16, 1959).

The equivalence of the pseudoscalar and pseudovector couplings of pseudoscalar pions to nucleons is investigated in a straightforward manner without making any use of a canonical transformation as has been done previously. PS-coupling is shown to be equivalent, as far as the S-matrix is concerned, to the usual p-wave and s-wave terms along with some non-local terms whose interpretation is not yet clear.

530.145

6530. A GENERAL TRANSFORMATION OF THE SYMMETRICAL PSEUDOSCALAR THEORY. A.Pais and R.Serber.
Phys. Rev., Vol. 113, No. 3, 955-8 (Feb. 1, 1959).

The symmetrical pseudoscalar theory with extended source is subjected to a rigorous transformation in such a way that the transformed Hamiltonian depends explicitly on the total isotopic spin and total angular momentum of the system. These collective variables are introduced by the same method of employing a general distribution function which was previously studied by the authors for the charged scalar theory.

530.145

6531. A SOLUBLE PROBLEM IN DISPERSION THEORY.

M.L.Goldberger and S.B.Treiman.
Phys. Rev., Vol. 113, No. 6, 1663-9 (March 15, 1959).

The Lee model is modified by addition of a new field θ and a weak coupling $N + \theta \rightarrow N + \theta'$, which leads to instability of the V particle: $V \rightarrow N + \theta \rightarrow N + \theta'$. The decay amplitude is calculated to lowest order in the weak coupling by dispersion relation methods. In effect we are required to study a set of simultaneous dispersion relations. The problem is completely soluble and serves to clarify the essential structure of dispersion methods. The results agree with what one obtains, more easily in the present case, by direct methods.

530.145 : 539.14

6532. THE TWO-NUCLEON INTERACTION. R.J.N.Phillips.

Rep. Progr. Phys., Vol. 22, 562-634 (1958).

Reviews advances in understanding the interaction of two nucleons, both phenomenologically and in terms of a fundamental meson—nucleon coupling.

530.145

6533. HARMONIC OSCILLATOR WAVE PACKETS. S.T.Epstein.

Amer. J. Phys., Vol. 27, No. 5, 291-3 (May, 1959).

Time-dependent operators are used to find harmonic oscillator wave packets which oscillate without change in shape. The results are in agreement with those of Senitzky (Abstr. 9953/1954) and others. Some useful averages are computed for these packets and some comments are made on the classical limit.

530.145

6534. ANGULAR MOMENTUM IN SPHERO-CONAL CO-ORDINATES. R.D.Spence.

Amer. J. Phys., Vol. 27, No. 5, 329-35 (May, 1959).

Angular momentum eigenfunctions obtained by separation of variables reflect the symmetry of the coordinate system in which the variables are separated. The sphero-conal angular momentum eigenfunctions lack the z axis symmetry of their spherical counterparts and are therefore particularly useful in dealing with certain physical problems which exhibit the same lack of symmetry. The theory of the sphero-conal eigenfunctions is outlined. Graphs of the eigenfunctions and eigenvalues for $l = 1, 2, 3, 4$ are given. The eigenvalues are interpreted in terms of certain operators and semi-classical pictures of the motion of the angular momentum vector. Applications considered are the energy levels of the asymmetric top molecule and a nucleus with an electric quadrople moment in an electric field gradient.

530.145

6535. THE SOLUTION OF THE BETHE—GOLDSTONE EQUATION FOR NON-ZERO CENTRE-OF-MASS MOMENTUM.

E.Werner.
Nuclear Phys., Vol. 10, No. 6, 688-97 (May (1), 1959).

The problem of the motion of two particles with non-zero centre-of-mass momentum is discussed for nuclear matter. In a mathematically rigorous treatment, the equation of motion is reduced to a set of integro-differential equations that couple together the contributions of the various angular momentum substates present in the total wave-function.

530.145

6536. ON EXTENDED CONFORMAL TRANSFORMATIONS OF SPINORS AND SPINOR EQUATIONS. H.A.Buchdahl.

Nuovo Cimento, Vol. 11, No. 4, 496-506 (Feb. 16, 1959).

Deals in the first place with the behaviour of spinors of arbitrary valence, and of their first derivatives, under transformations of the extended conformal group C, whose elements are basically the transformations of the metric according to $'g_{kl} = \lambda g_{kl}$, where λ is an arbitrary positive function of the coordinates. The results obtained are applied to certain relativistic equations for fields associated with particles of arbitrary spin S. It is shown that: (i) if the mass-scalar κ which occurs in them is taken to be a conformal invariant, then the equations cannot be invariant under C for any value of S; (ii) if κ is taken to be a conformal covariant, then the equations can be invariant under C only if they are reflection-invariant and S is half-odd integral, and the subsidiary equations are imposed after transformation, i.e. they are not themselves required to be invariant; (iii) if the conformal invariance of the subsidiary equations also is required then the only equations which can be invariant under C are Dirac's equations ($S = \frac{1}{2}$) with conform-covariant mass-scalar, the subsidiary equations being absent in this case.

530.145

6537. LOW-TEMPERATURE BEHAVIOR OF A DILUTE BOSE SYSTEM OF HARD SPHERES. II. NONEQUILIBRIUM PROPERTIES.

T.D.Lee and C.N.Yang.
Phys. Rev., Vol. 113, No. 6, 1406-13 (March 15, 1959).

The calculation of a previous paper (Abstr. 4300/1959) is extended to cover nonequilibrium properties. The phenomena of superfluidity, critical velocity, and "infinite heat conductivity" are given natural explanations. By using classical kinetic theory on the wave packets, hydrodynamical equations for reversible flow are derived and the dependence of the two "sound velocities" on the temperature studied. The relationship between macroscopic sound vibrations and microscopic excitations is analysed. The work is confined to the model of a dilute hard-sphere Bose system.

530.145

6538. SPECTRAL REPRESENTATIONS IN PERTURBATION THEORY. II. TWO-PARTICLE SCATTERING.

R.Karplus, C.M.Sommerfield and H.Wichmann.
Phys. Rev., Vol. 114, No. 1, 376-82 (April 1, 1959).

For Pt I, see Abstr. 3152 (1959). In this paper a particular term in the perturbation expansion for the two-particle scattering amplitude is examined. The real plane defined by the square of the total four-momentum and the square of the momentum transfer is considered, and it is shown that the scattering amplitude is an analytic function of both variables in a certain connected region in this plane. The precise boundary of the region is found. The purpose of this work is to find some conditions that integral representations of the scattering amplitude must satisfy, with the hope that such examples may aid the study of such integral representations in general. The general result is applied to some particular cases of physical interest.

STATISTICAL MECHANICS

TRANSFER PROCESSES

530.16 : 518.5

6539. ON THE THEORY OF RELAXATION. II. ELECTRICAL NETWORK MODELS FOR THE RELAXATION PROPERTIES OF MATTER. S.Kästner.

Ann. Phys. (Leipzig), Folge 7, Vol. 2, No. 3-4, 146-62 (1958).
In German.

For Pt I, see Abstr. 63 (1959). For an arbitrary thermodynamic relaxation process one can construct electrical analogues by using either LC or RC networks together with ideal transformers. In special cases one can dispense with the transformers and thus make the system open to easy investigation by actually constructing the analogues. These cases include (a) a single thermodynamic variables, which gives rise to a 2-pole network; (b) two thermodynamic variables, corresponding to a 4-pole network; (c) the case of weak coupling, which gives a simplified multipole network.

R.O.Davies

530.162

6540. MATHEMATICAL METHODS OF STATISTICAL MECHANICS. [Méthodes mathématiques de la mécanique statistique]. A.Blanc-Lapierre, P.Casal and A.Tortrat.

Paris: Masson et Cie [1959] x + 180 pp. [Collection d'Ouvrages de Mathématiques a l'Usage des Physiciens]. In French.

This book concerns mainly the rigorous treatment of some basic mathematical problems in classical statistical mechanics. It resembles Khinchine's "Statistical Mechanics" [New York: Dover (1949)] in scope and method, but is more detailed and contains new results, including some applying to quantum statistics. Chapter I introduces the basic ideas and hypotheses of statistical mechanics. Chapter II shows how the relevant results of classical mechanics can be interpreted as geometrical properties of phase space. Chapter III explains the ergodic theorems of Birkhoff and Neumann entailed by these properties. Chapter IV deals with the classical theory of systems composed of a large number of weakly coupled "components"; the ergodic theory of such systems is discussed, and the probability distribution for a small component is derived using characteristic functions. Chapter V extends the results of the preceding chapter to quantized systems, leading to the B.E. and F.D. distribution laws. There is no detailed discussion of quantum ergodic problems.

O.Penrose

530.162

6541. ADIABATIC INVARIANCE TO ALL ORDERS. A.Lenard.

Ann. Phys. (New York), Vol. 6, No. 3, 261-76 (March, 1959).

Adiabatic invariance theorems are extended to all orders in the slowness parameter. The concept of adiabatic invariance to all orders is formulated precisely. A classical one-dimensional non-linear oscillator is treated. It is proved that the action integral extended over a period of the instantaneous time independent problem is an adiabatic invariant to all orders. The Born—Fock quantum mechanical adiabatic theorem is extended to all orders. The systems to which the proof applies in all rigour are those which have a finite number of nondegenerate quantum states which do not cross in the process of adiabatic change. The proofs are based on a systematic construction of the asymptotic expansion in the slowness parameter of the statistical distribution function which describes an initially stationary ensemble of systems.

530.162

6542. ON THE CODING THEOREM AND ITS CONVERSE FOR FINITE-MEMORY CHANNELS. A.Feinstein.

Information and Control, Vol, 2, No. 1, 25-44 (April, 1959).

A new definition for the capacity C of a (discrete or semicontinuous) channel with finite memory is given. In terms of this definition both the coding theorem and its weak converse are easily established. In particular, all questions of the ergodicity of the source-channel distribution are avoided, and we are able to show for discrete, channels that both the ergodic and stationary capacities (as given by the Shannon—McMillan definition) coincide with that given here. The strong converse of the coding theorem is shown to hold for a particular finite-memory channel recently considered by Wolfowitz.

530.162

6543. INEVITABLE EXPERIMENTAL ERRORS, DETERMINISM, AND INFORMATION THEORY. L.Brillouin.

Information and Control, Vol. 2, No. 1, 45-63 (April, 1959).

Classical physics was based upon the assumption that experimental errors were just accidental and should be ignored by the theory. Modern physics realizes that errors are inevitable and that it is impossible to go to the limit of infinitely small errors. The uncertainty principle and the negentropy principle of information prove that the smaller the error, the greater the price that must be paid for the observation. There is no exact limit to the accuracy, but its high cost makes it unattainable. Classical physics assumed complete determinism. The new modern "matter of fact" point of view states the impossibility to prove this assumption. If experimental errors are very small, it takes a longer time to reach the final statistical distribution, but this final state of statistical equilibrium will always be reached. Many examples are discussed, and the "matter of fact" point of view is compared with similar ideas presented by the Vienna school, by Born and by the Copenhagen school.

530.162

6544. ENTROPY AND THE UNCERTAINTY PRINCIPLE. R.Leipnik.

Information and Control, Vol. 2, No. 1, 64-79 (April, 1959).

A minimum principle is obtained for the sum of entropies of two distributions related as the absolute squares of a Fourier transform pair. The minimum is shown to be attained for a Gaussian pair. The joint entropy is calculated for two other Fourier pairs of interest. Applications to the uncertainty principle are made by defining a joint entropy for position and momentum. A generalized uncertainty principle, for any set of observables not simultaneously measurable, is conjectured.

530.162

6545. ENERGY FLUCTUATIONS IN AN OPEN SYSTEM. R.M.Mazo and J.E.Mayer.

J. chem. Phys., Vol. 30, No. 1, 333 (Jan., 1959).

The usual expression for the energy fluctuation, $\langle E^2\rangle - \langle E\rangle^2$, depends on the choice of energy zero. The alternative expression proposed and briefly investigated is $\langle (E - \epsilon N)^2\rangle$, where $\epsilon = \langle E\rangle/\langle N\rangle$. It is independent of the choice of energy zero.

P.T.Landsberg

530.162

6546. ON A RELATION BETWEEN COARSE GRAINING AND DIAGONAL SINGULARITY. S.A.Rice.

J. chem. Phys., Vol. 30, No. 2, 587-8 (Feb., 1959).

Demonstrates a close connection between the method of Van Hove and Prigogine and the method of Kirkwood of introducing irreversibility into theories of large systems. J.Hawgood

530.162 : 541.135

6547. GENERAL APPROACH TO THE STUDY OF ELECTRICAL CONDUCTANCE AND ITS RELATION TO MASS TRANSPORT PHENOMENA. R.W.Laity.

J. chem. Phys., Vol. 30, No. 3, 682-91 (March, 1959).

A method of writing phenomenological equations for the description of electrical and mass transport, based on approaches of Onsager and Klemm, is shown to give rise to a set of coefficients defined in a particularly useful and economical way. Conceptually akin to friction coefficients, these quantities are shown to tie together the results of such very different measurements as electrical conductance, transference numbers, and diffusion coefficients in such a way that a single type of physical concept can be applied in interpreting the results of all three. The characteristics of the phenomenological friction coefficients are examined for three different classes of electrolyte: electrolytic solutions, ionic crystals, and molten salts. Known limiting relations, such as the Nernst—Einstein relation, are shown to follow from the macroscopic treatment in cases where they are experimentally valid. In certain cases it is shown how the macroscopic treatment can be made more consistent with a microscopic model through alternative selection of the entities to be taken as components. Some macroscopic criteria are offered as bases for such selection in cases where more than one possibility seems reasonable.

530.162

6548. PERTURBATION CALCULATIONS IN EQUILIBRIUM STATISTICAL MECHANICS. I. HARD SPHERE BASIS POTENTIAL. E.B.Smith and B.J.Alder.

J. chem. Phys., Vol. 30, No. 5, 1190-9 (May, 1959).

A study is made of the effect of potential perturbations on the equilibrium properties of a hard sphere system at both high and low densities. The perturbation is evaluated beyond the first-order term for the second and third virial coefficients to estimate the region of convergence. The results of the first-order perturbation from the virial expansion, superposition theory, and free-volume theory are compared. A comparison with experimental data is made to show the applicability of this perturbation from a hard sphere potential to the estimation of the equilibrium properties of a great variety of gases at moderately high temperatures.

530.162 : 533.7

6549. TRANSPORT PHENOMENA IN A FLUID COMPOSED OF DIATOMIC MOLECULES. J.S.Dahler.

J. chem. Phys., Vol. 30, No. 6, 1447-75 (June, 1959).

It is shown that the formal theory of transport processes developed by Kirkwood, Irving, Zwanzig, and Ross can be extended to fluids composed of polyatomic molecules. The hydrodynamical equations are established for the case of classical mechanics and these relationships are shown to obtain in the quantum theory. Equations of change for the classical distribution functions are given, special attention being paid to cases where the intermolecular forces are impulsive. The quantum theory is formulated in terms of generalized Wigner functions, i.e., Fourier transforms of the density matrix. In terms of these functions the transport properties of a dilute polyatomic fluid may be represented as those of a mixture whose components are molecules with different internal quantum states. Finally, the equations of change for the Wigner functions and the quantum analogue of the Boltzmann integro-differential equation are considered.

530.162

6550. EXACT DEFINITION OF QUASI-THERMODYNAMIC POINT FUNCTIONS IN STATISTICAL MECHANICS. T.L.Hill.

J. chem. Phys., Vol. 30, No. 6, 1521-3 (June, 1959).

Provides a rigorous definition and justification for the use of a "local" or "point" chemical potential (or activity coefficient), constant in value, in a transition region between two phases, or in the immediate neighbourhood of a particular molecule or ion in a homogeneous fluid or solution. In the transition case, other quasi-thermodynamic point functions are also given exact definition; for example, the Helmholtz free energy, internal energy, and entropy. Possible applications, past and future, include the theory of liquids, solutions, electrolytes, and surface tension.

530.162

6551. STATISTICAL MECHANICS OF MULTICOMPONENT SYSTEMS: PERTURBATION THEORY. L.H.Nosanow.

J. chem. Phys., Vol. 30, No. 6, 1596-604 (June, 1959).

The molecular Gibbs free energy of a conformal solution is treated by the use of perturbation theory. A general expansion is given, the zeroth order term of which is a linear combination of the molecular Gibbs free energies of suitably chosen one component systems. A criterion is given for the choice of these systems that leads to a unified derivation of three well-known approximations which involve the use of composition dependent pair potentials. The second-order term of the general expansion is used to give a discussion of these approximations. A workable procedure for computing this term is given.

530.162

6552. INFORMATION THEORY AND ITS APPLICATIONS TO FUNDAMENTAL PROBLEMS IN PHYSICS. L.Brillouin.
Nature (London), Vol. 183, 501-2 (Feb. 21, 1959).

A brief and popular survey of concepts such as uncertainty relations, negentropy principle of information, Laplace's demon (who knows the positions and velocities of all atoms in the universe), etc. P.T.Landsberg

530.162

6553. RESULTS OF THE CALCULATION OF THE PROPAGATION OF ERRORS IN THE SOLUTION OF FALTUNG INTEGRAL EQUATIONS, AND THEIR SIGNIFICANCE FOR COMMUNICATION POSSIBILITIES IN NATURE. H.Wolter.
Naturwissenschaften, Vol. 45, No. 23, 565-6 (1958). In German.

530.162

6554. THE PARTITION FUNCTION AND THE SUBSIDIARY CONDITIONS IN THE BOHM—PINES AND MIGDAL—GALITSKY'S SUPPLEMENTARY VARIABLES METHOD.
A.Pawlikowski and W.Szczurówna.
Nuovo Cimento, Vol. 11, No. 5, 635-43 (March 1, 1959).

The supplementary variables method is applied to the approximate calculation of the partition function of N interacting fermions. It is shown that the supplementary variables method in its original formulation due to Bohn—Pines and Migdal—Galitsky leads to wrong results. One obtains correct results if one assumes a modification, due to Kanazawa of the subsidiary conditions in this method.

530.162

6555. COLLECTIVE DESCRIPTION OF ELECTRON INTERACTIONS WITHOUT SUBSIDIARY CONDITIONS. H.J.Lipkin.
Phys. Rev. Letters, Vol. 2, No. 4, 159-61 (Feb. 15, 1959).

It is shown that within a certain approximation it is possible to obtain (1) similar results to those of Bohm and Pines without introducing additional degrees of freedom; (2) the Bohm—Pines extended Hamiltonian with additional degrees of freedom but without requiring subsidiary conditions. D.M.Edwards

530.162 : 535.317.1

6556. REDUNDANCY PROBLEM. P.M.Duffieux.
Rev. Opt., Vol. 38, No. 2, 75-83 (Feb., 1959). In French.

The harmonic analysis of a function F(x), limited to a domain D, yields the terms for a Fourier series, i.e. a discontinuous spectrum of integrable points. The spectral analysis of the same function by a periodograph may yield the continuous and boundless transform of that function in the boundless x-domain. There is an apparent redundancy of the continuous spectrum with respect to the discontinuous spectrum, which is known to be a selection of points from the former. However, the information given by the periodograph method scatters out of the domain D for a deficient definition of the parts which are outside this domain and determined through the experimental technique. Only the points of the discontinuous spectrum are valid in metrology, but any accurate measurement requires a redundancy of experimental data. It is concluded that any information about a physical phenomenon, which is always a limited one, is also limited and numerable.

530.162 : 771.531

GRAININESS AND ENTROPY. See Abstr. 6426

GENERAL MECHANICS

MECHANICS OF SOLIDS

531 : 530.1

PREDICTABILITY IN CLASSICAL MECHANICS.
See Abstr. 5342

531.01

6557. LINEAR EIGENVALUE PROBLEMS IN MECHANICS. (A CONTRIBUTION TO THE THEORY OF NATURAL EIGENVALUE PROBLEMS). E.Bukovics.
Acta phys. Austriaca, Vol. 12, No. 3, 262-303 (1959). In German.

A general variational formulation of the "natural" eigenvalue problem is set up having properties characteristic of many problems involving the stability and vibrations of mechanical systems. The boundary conditions satisfied in a system of order 2 m are subdivided into s essential, or "kinematic", conditions involving derivatives of order less than or equal to m-1, and 2m-s residual, or "dynamic", conditions which may involve derivatives of higher order and coefficients which may be dependent on the eigenvalues of the system. A number of classical eigenvalue theorems are extended to such systems. R.A.Newing

531.132 : 621.836

6558. EXACT LINEAR SIMPLE HARMONIC MOTION BY A SPACE-LINKAGE. K.H.Hunt.
Austral. J. appl. Sci., Vol. 9, No. 4, 332-6 (Dec., 1958).

A range of space-linkages is described for converting uniform rotation into linear simple harmonic motion. These "geometrical concepts" are all exact and may be incorporated in practical mechanisms whose accuracy is limited only by deformations in the members and working clearances. The mechanisms lend themselves readily to amplitude variation while they are running.

531.258

6559. A THIN CIRCULAR PLATE NORMALLY AND UNIFORMLY LOADED OVER A CONCENTRIC ELLIPTIC PATCH.
W.A.Bassali and M.Nassif.
Proc. Cambridge Phil. Soc., Vol. 55, Pt 1, 101-9 (Jan., 1959).

Concerned with the small transverse displacement of a thin circular plate elastically restrained along the circular boundary and subject to uniform normal pressure distributed over the area of an ellipse concentric with the plate. The method of complex potentials is used and the general assumptions relating to the small deflection theory of thin plates are adopted. Explicit formulae for the bending and twisting moments and shearing forces are given at any point on the boundary and at the centre of the plate.

531.258

6560. BENDING OF A THIN CIRCULAR PLATE UNDER HYDROSTATIC PRESSURE OVER A CONCENTRIC ELLIPSE.
W.A.Bassali.
Proc. Cambridge Phil. Soc., Vol. 55, Pt. 1, 110-20 (Jan., 1959).

An exact solution in finite terms is derived within the limitations of the classical thin-plate theory, for the problem of a thin circular plate acted upon normally by hydrostatic pressure distributed over the area of a concentric ellipse, and subject to boundary conditions covering the usual rigidly clamped and simply supported boundaries.

531.258

6561. THE ANALYSIS OF SINGULARLY LOADED AND RIGIDLY CLAMPED THIN ELASTIC SLABS WITH CURVILINEAR BOUNDARIES. I. W.A.Bassali.
Proc. Cambridge Phil. Soc., Vol. 55, Pt 1, 121-36 (Jan., 1959).

Complex variable methods are used to derive exact solutions in closed forms for the small deflections of certain thin elastic plates due to transverse concentrated forces or couples applied at arbitrary or specified points. The isotropic plates considered are bounded by curvilinear edges of certain types along which the plates are rigidly clamped. Plates bounded by quartic curves having the forms of the inverses of an ellipse with respect to its centre or its focus are included as special cases.

531.261.3 : 550.312

6562. MAXIMUM GRAVITY EFFECT OF CERTAIN SOLIDS OF REVOLUTION. L.Duska.
Geophysics, Vol. 23, No. 3, 506-19 (July, 1958).

Presents formulae for calculating the gravitational attraction, at points on their central vertical axes, of several solids of revolution. Such calculations are sometimes desirable to find the maximum anomalies which may be caused by geologic bodies which are assumed to have the approximate shape of a solid of revolution. A reasonable set of density differences must be used in such preliminary gravity calculations to find the limits of the anomalies to be expected. A table of formulae is presented.

531.5

6563. EÖTVÖS BALANCE. B.G.Kolossvary.
Amer. J. Phys., Vol. 27, No. 5, 336-43 (May, 1959).

Appreciation of potential, equipotential surfaces, and related concepts is more readily obtained on college level through the discussion of the theory and operation of the Eötvös balance. Description of the different kinds of balances suitable for various gravity measurements, the physical interpretation and measurement of the second partial derivatives of the potential function, as well as some experiments for advanced college students, are discussed.

531.55

6564. GENERALIZATION OF THE BASIC EQUATION OF THE DYNAMICS OF ROCKETS. N.S.Kalitzin.
Nuovo Cimento, Vol. 11, No. 2, 298-9 (Jan. 16, 1959). In German.

The author generalizes the basic equation of Tziolkovsky (relating velocities and masses of rocket and of its shed-off parts), to arbitrarily curved paths under relativistic conditions.

J.K.Skwirzynski

531.577

6565. CONCERNING THE DESIGN OF AN EFFECTIVE SHAPED CHARGE FOR OIL WELL PERFORATING.
J.S.Rinehart and R.D.Cocanower.
J. appl. Phys., Vol. 30, No. 5, 680-2 (May, 1959).

Current shape charge theory and experiment do not provide the requisite basis for the development of a slug-free charge suitable for oil well perforation. Considerations and experiments are discussed which have led to the design of a new type charge. Basically the charge has a thicker than conventional liner containing a low melting point metal which melts during collapse, forming a liquid slug which is dispersed.

MECHANICAL MEASUREMENTS

531.711 : 529.786 : 535.33

ATOMIC STANDARDS OF LENGTH AND TIME.
See Abstr. 5492

531.715 : 535.417

PARALLEL TESTING INTERFEROMETER.
See Abstr. 5588

531.715.1 : 535.417

DEVELOPMENTS IN THE COMPARISON OF LENGTHS USING FRINGES OF SUPERPOSITION IN WHITE LIGHT. See Abstr. 5592

531.715.2 : 535.822

6566. MEASUREMENT OF SUBMICRON CIRCULAR APERTURES BY SCANNING MICROSCOPY. P.N.Slater.
J. Opt. Soc. Amer., Vol. 49, No. 6, 562-7 (June, 1959).

Experiments are described in which submicron circular apertures of known diameter in an opaque aluminium film are scanned under different conditions. The effects of varying the numerical aperture, focus, and tube length of the scanning objective and the wavelength and polarization of the light used are noted. The use of two different sizing parameters in automatic high-resolution scanning microscopy is discussed.

531.717 : 539.234

ON THE MEASUREMENT WITH AN IONIZATION GAUGE OF THE DENSITY IN A VAPOUR STREAM FOR THE PRODUCTION OF THIN FILMS ON A SUBSTRATE. See Abstr. 6313

531.768

6567. CALIBRATION OF ACCELEROMETERS IN A SIMULATED SPACE ENVIRONMENT. D.N.Keast.
J. Acoust. Soc. Amer., Vol. 31, No. 5, 584-7 (May, 1959).

For the purpose of measuring the properties of cushioning materials under simulated space conditions, it has been necessary to calibrate accelerometers for use in this unusual environment. In this paper, calibrations over the temperature range from −320° to +80° F, and at an atmospheric pressure of 5×10^{-5} mm Hg, are reported for several different types of barium titanate accelerometers. These calibrations were obtained at several frequencies between 200 and 100 c/s by the optical viewing method.

531.787 : 539.1.07 : 621.317.39

6568. A DEVICE FOR DYNAMICAL MEASUREMENTS OF PRESSURE. P.Bassi, R.Cano, S.Focardi, C.Rubbia, A.Michelini and F.Saporetti.
Nuovo Cimento, Vol. 11, No. 4, 589-92 (Feb. 16, 1959).

A device for fast measurements of pressure variations to be used in liquid hydrogen bubble chamber technique, is described. Its characteristic features are speedy and linear response, output signal independence of cable capacity variations, possibility of adjustment at a distance and simplicity of the detecting circuit.

531.787.4

6569. LIQUID MANOMETER WITH PHOTOELECTRIC SCANNING. K.Scheibe and W.Wuest.
Z. InstrumKde, Vol. 66, No. 9, 185-8 (Sept., 1958). In German.

The level of the meniscus is observed photoelectrically and recorded. The complete instrument and its components are described in detail.

S.Weintroub

MECHANICS OF FLUIDS

532 : 536.42

6570. LIQUID BEHAVIOR OF EXPLODING WIRES. W.G.Chace.
Phys. of Fluids, Vol. 2, No. 2, 230-5 (March-April, 1959).

Experiments were performed to secure evidence of the mechanism during the early stages of a wire explosion. High-speed (0.3 μsec) photographs were taken, using a second exploding wire to back-light the first. The results showed no surface irregularities (unduloids) as frequently postulated for the liquid phase of exploding wires. Instead, the evidence points to a condition of extreme superheating of the liquid, followed by sudden explosive vaporization ("transplosion"). Stria in the ensuing vapour cloud were found to develop after the explosion is complete.

532.133 : 539.19

6571. THE RELATIONSHIP BETWEEN VISCOSITY AND MOLECULAR STRUCTURE. II. THE TEMPERATURE DEPENDENCE OF THE VISCOSITY OF HYDROXYLIC COMPOUNDS. PRELIMINARY ACTIVATION ENERGY DATA ON GLYCEROL AND ETHYLENE GLYCOL. M.Naseem and M.M.Qurashi.
Pakistan J. sci. industr. Res., Vol. 1, No. 3, 197-206 (July, 1958).

For Pt I, see ibid., Vol. 1, No. 2, 116, (1958). Data are presented for glycerol from 30°C to 205°C and for ethylene glycol from 75°C to 150°C. The curves of activation energy of viscous flow against temperature exhibit step-like segments characteristic of each liquid. Details are given of the experimental work and the precautions taken to ensure high accuracy.

G.I.W.Llewelyn

532.133

6572. HIGH PRESSURE INVESTIGATIONS. IV. THE VISCOSITY-PRESSURE BEHAVIOUR OF HIGH MOLECULAR SUBSTANCES. E.Kuss.
Z. angew. Phys., Vol. 10, No. 12, 566-75 (Dec., 1958). In German.

For Pt III, see Abstr. 8531 (1955). Viscosity-pressure relations were determined for a wide range of high molecular weight substances at several different temperatures for pressures up to 2000 atm. The method used was that of the falling sphere, using electromagnetic means for detecting the position of the sphere, in conjunction with a thyratron circuit for automatic recording. Good accuracy was achieved.

T.C.Toye

532.5 : 530.12

RELATIVISTIC HYDRODYNAMICS FOR A CHARGED NON-VISCOUS FLUID. See Abstr. 6500

532.51 : 536.48

HYDRODYNAMIC PROBLEM OF THIRD AND FOURTH SOUND IN LIQUID HELIUM II. See Abstr. 5630

532.517

6573. STATIONARY MOTION OF VISCOUS FLUID AROUND A ROTATING SOLID SPHERE. Z.Sakadi.
Mem. Fac. Engng Nagoya Univ., Vol. 10, No. 1, 42-5 (May, 1958).

532.517.3

6574. FLOW THROUGH CAPILLARY TUBING WITH ECCENTRIC ANNULAR SECTIONS. C.H.Bachman and H.G.Hottenrott.
Rev. sci. Instrum., Vol. 30, No. 2, 126-31 (Feb., 1959).

Gas flow through capillaries obstructed by wire inserts was investigated for ratios of core to capillary diameters (B/A's) of 0.08 to 0.9. For a given core-capillary combination, laminar and turbulent as well as an intermediate region are well defined. Deviations from Poiseuille flow for the range of B/A's are presented in a working curve, which will give flow rates for laminar flow correct to from 5 to 10%. The pressure drop v. flow curves for the intermediate and turbulent flow regions are reasonably reproducible. The use of the cored capillary for very small leak rates looks especially attractive because, with large B/A's such that the maximum crescent clearance is less than 0.25 mm, the onset of turbulence is postponed to much higher pressure drops.

532.522

6575. DEVELOPMENTS IN DIFFERENTIAL PRODUCERS FOR FLOW MEASUREMENT. H.E.Dall.
Instrum. Engr, Vol. 2, No. 7, 144-7 (April, 1959).

Primarily concerned with those types of differential producers (also called p.d. or d.p. devices) developed for special duties, or having favourable characteristics not attainable with earlier devices. Intake devices, special devices for measurements at low Reynolds numbers, and the less-common forms of orifice are considered. Abnormal installation conditions are discussed briefly.

532.525

6576. MECHANISM OF CRATERING IN ULTRA-HIGH VELOCITY IMPACT. M.A.Cook.
J. appl. Phys., Vol. 30, No. 5, 725-35 (May, 1959).

The equations of the hydrodynamic theory of penetration of targets by shaped charge jets are presented first in general form. These equations are then expressed in the ideal form and examined by experimental observations. Then a nonideal theory is presented that takes into account heat losses by compression, shock heating, and radiated shock waves. The conditions for impact explosions of targets are then discussed and a theory extended to cover the entire velocity range of impact from the plastic deformation threshold v_σ to well above the impact explosion threshold v_c. Some experimental evidence relating to this more general theory is also presented.

532.528

6577. THE PROBLEM OF CAVITATIONAL EROSION.
A.S.Bebchuk, Yu.Ya.Borisov and L.D.Rozenberg.
Akust. Zh., Vol. 4, No. 4, 361-2 (1958). In Russian.

See also Abstr. 927, 3761, 4784 (1958). The magnitude of cavitational erosion depends on the number of bubbles formed and the rate of their collapse. The authors found that the acoustic noise of cavitation is also a function of the rate of formation and collapse of bubbles. Experiments at 8.1 kc/s on aluminium in water, in water with a surface-active agent and acetone established that the acoustic cavitational noise (mean square of the pressure) is proportional to the cavitational erosion (rate of loss of mass).

A.Tybulewicz

532.542.8 : 536.24

THE EFFECT OF INLET FLOW DISTURBANCES ON THE HEAT TRANSFER IN LIQUIDS IN PIPES AND ANNULAR CHANNELS. See Abstr. 5614

532.59

6578. WATER WAVES PRODUCED BY EXPLOSIONS.
H.C.Kranzer and J.B Keller.
J. appl. Phys., Vol. 30, No. 3, 398-407 (March, 1959).

Explicit formulae are found for the height of the water waves produced by an arbitrary axially symmetric initial disturbance in water of finite depth. The initial disturbance can be either a distribution of impulse or an elevation or depression of the surface or a combination of these. Upper bounds on the wave height are given to be used when the approximate size of the initial disturbance is known, but not its detailed shape. These results are applied to determine the wave resulting from the explosion of a typical large bomb above the surface. The corresponding formulae for waves in a one-dimensional channel are also derived and are compared with experimental results.

532.6 : 539.217

6579. PERMEABILITY [TO LIQUID FLOW] OF POROUS MEDIA.
R.J.Millington and J.P.Quirk.
Nature (London), Vol. 183, 387-8 (Feb. 7, 1959).

Outlines a theory of flow, assuming nearly spherical pores, and obtains a formula connecting permeability with water content for $\frac{1}{2}$-$\frac{1}{4}$ and 1-$\frac{1}{2}$ mm sands; good agreement is found with experiment. Results calculated from Marshall's theory (Journal of Soil Science, Vol. 9, 1, 1958) do not agree with experiment. The author's theory also describes accurately the behaviour of a liquid passing through a Linde silica plug, of porosity 10^{-9} less than that of the sand.

N.Corcoran

532.61.08 : 539.213

6580. SURFACE TENSION AND DENSITY MEASUREMENTS ON MOLTEN GLASSES IN THE $CaO.\ Al_2O_3.\ SiO_2$ SYSTEM.
L.R.Barrett and A.G.Thomas.
J. Soc. Glass Technol., Vol. 63, 179T-190T (April, 1959).

The measurements, using a modification of the maximum bubble pressure method, are described for a series of glasses in the lime-alumina-silica system. Statistical analysis of the results leads to the postulation of a series of general relationships between composition and density or surface tension, and their temperature coefficients, for this system. In the light of these relationships a model for the structure of molten silicates is discussed.

532.61.08

6581. THE MEASUREMENT OF SURFACE TENSION FOR THE PURPOSE OF PROCESS CONTROL. W.H.Aarts.
S. African J. Sci., Vol. 55, No. 4, 103-7 (April, 1959).

The methods used in instrumental process control are reviewed and the use of surface tension is discussed. An instrument (epitasimeter) using the ratio of surface tension to density for continuously measuring the concentrations of a process solution is described.

532.612.3

6582. FLATTENING OF A NEARLY PLANE SOLID SURFACE DUE TO CAPILLARITY. W.W.Mullins.
J. appl. Phys., Vol. 30, No. 1, 77-83 (Jan., 1959).

The relaxation of a nearly plane surface to flatness is discussed under the assumption that all surface properties are independent of orientation. A general solution is obtained for the combined action of the transport processes of viscous flow, evaporation—condensatio (in a closed system), volume diffusion, and surface diffusion. Green function solutions are developed for each of the transport processes separately, and criteria are obtained to decide which process dominates. The initial forms of these solutions represent point concentrations (particles), or line concentrations (wires) of material set upon an infinite plane. The progressive topographical developments described by the formulae are idealized representations of the latter stages of the sintering of small wires and particles to a plane.

532.612.4

6583. SURFACE TENSION AND DENSITY OF TERNARY SYSTEMS AT THEIR NORMAL BOILING POINT.
H.R.Crawford and M.Van Winkle.
Industr. engng Chem., Vol. 51, No. 4, 601-6 (April, 1959).

A correlation has been developed which enables the prediction of the surface tension of a multicomponent system, at the boiling point of the mixture, as a function of composition. Values so obtained are well within the generally accepted engineering degree of accuracy.

532.6

6584. THE CAPILLARY RISE OF A LIQUID IN A VERTICAL STRIP OF FILTER PAPER. T.Gillespie.
J. Colloid Sci., Vol. 14, No. 2, 123-30 (April, 1959).

A theory previously developed by the author [J. Colloid. Sci., Vol. 13, No. 1, 32-50 (Feb., 1958)] to describe the horizontal spreading of liquids in paper has been applied to the case of a liquid rising by capillary action in a vertical strip of filter paper. The phenomenon is complicated by a surface roughness effect which had to be taken into account. The theory leads to simple expressions for the rate of rise and the distribution of liquid, which are in agreement with experiment. When gravity can be neglected, the height of rise is proportional to the square root of the time. When gravity is important the height of rise is a more complex function of time than the simple square root dependence. In addition, the liquid approach a limiting height.

532.64

6585. RELATIONSHIP OF THE CONTACT ANGLE TO INTERFACIAL ENERGIES. J.E.McNutt and G.M.Andes.
J. chem. Phys., Vol. 30, No. 5, 1300-3 (May, 1959).

The commonly used relation between the contact angle and the specific free energies of three surfaces meeting at a line is correct, although it has been criticized in recent years. A rigorous derivation of the kind applicable to systems which can be analytically described is presented in detail. The completely general derivation of Gibbs is also reviewed. The kinds of errors in the derivations found in many texts are discussed.

532.64 : 535.417

6586. STUDY OF THE ANGLES OF CONTACT OF LIQUID SURFACES WITH SOLIDS BY INTERFERENCE IN POLARIZED LIGHT. M.Françon and Y.Gandon.
Optica Acta, Vol. 5, No. 3-4, 78-88 (Sept.-Dec., 1958). In French.

This method, based on the doubling of the incident wave by a birefringent system, makes possible a measurement of the slope of the wave surface at each point. The main purpose of the present work was to determine the possibility of using the method for measuring angles of contact, and to explain the phenomena in particular cases: drops of liquid, cylindrical films or threads. (See also Abstr. 6696/1958).

MOLECULAR THEORY OF LIQUIDS

532.7 : 539.213

6587. MOBILITY OF MOLECULES IN LIQUIDS NEAR THE GLASS TEMPERATURE. F.Bueche.
J. chem. Phys., Vol. 30, No. 3, 748-52 (March, 1959).

A theory for the molecular motion in liquids is formulated. It treats the system as a series of molecular shells bound elastically to each other and to a central molecule. The vibrations of this system are analysed approximately in an effort to find the probability that the central molecule will be left in a hole large enough so it can move to a new position. It is found that the jump frequency of the molecules obeys an equation of the form exp $(-E/kT)$ at high temperatures but conforms to the W.L.F. equation (Abstr. 10019/1955) at low temperatures. The anomalous behaviour of liquids near the glass temperature is shown to result from the fact that a great deal of cooperation among adjacent molecules must occur if a molecule is to move at low temperatures. The molecular parameters needed to fit the experimental data available are found to be of reasonable magnitude. The influence of various factors such as molecular size, weight and attraction are also discussed. It is concluded that the glass transition is similar in high and low molecular weight substances and is not a property peculiar to macromolecules.

532.7

6588. ENERGY LEVELS OF BOUND ELECTRONS IN LIQUID AMMONIA. J.Jortner.
J. chem. Phys., Vol. 30, No. 3, 839-46 (March, 1959).

The properties of infinitely dilute metal ammonia solutions are interpreted on the basis of Landau's model for electron binding by polarization of the dielectric medium. The electrons are bound in cavities of radius 3.2-3.45 A. The energy levels of the trapped electrons are computed by the variation method using one-parameter wave-functions. It is possible to obtain theoretical values for the heat of solution of the electron and the energy of the $1s \rightarrow 2p$ transition in agreement with experimental data. The susceptibility of the energy of the electronic transition to temperature cannot be interpreted by the temperature dependence of the dielectric constant only, and it is presumed that the electron cavity radius is temperature dependent.

532.7

6589. DENSITY OF ELECTRONIC ENERGY LEVELS FOR A ONE-DIMENSIONAL LIQUID. J.Ford.
J. chem. Phys., Vol. 30, No. 6, 1546-50 (June, 1959).

The density of one-electron energy levels for a one-dimensional array of square wells whose positions are Gaussianly distributed independent random variables has been calculated. The Hamiltonian matrix elements are calculated using the tight-binding approximation and the Montroll moment-trace method is used to compute the first six moments of the density of states curve. Hermite and Legendre polynomial expansions are then used to obtain the density of states curve itself. This method is, of course, valid independent of dimension. The integrated density of states curve as here obtained agrees nicely with the computer solution given by Landauer and Helland.

532.7 : 534.21

6590. ON THE DERIVATION OF REACTION PARAMETERS FROM OBSERVATIONS OF ULTRASONIC RELAXATION. R.O.Davies and J.Lamb.
Proc. Phys. Soc., Vol. 73, Pt 5, 767-76 (May, 1959).

Measurements of ultrasonic relaxation in liquids and gases provide experimental data from which it is desired to obtain theoretically useful parameters such as heats of reaction and transition probabilities. It is shown here that even if full experimental results are available concerning the variation of the ultrasonic relaxation strength with pressure and temperature it is still necessary to make at least three assumptions before thermodynamic reaction parameters can be evaluated. The main purpose of the paper is to set out a logical theory which makes the nature of these assumptions explicit. It is first shown how the experimental results can best be analysed to yield the relaxation strength. The formula connecting the relaxation strength with the reaction parameters leads to a partial differential equation which is integrated in a form convenient for practical application. The general implications of the theoretical work are discussed in relation to experimental observations and the need for further experimental work at high pressures is emphasized.

532.7

6591. ON REDUCING THE EFFECT OF THE LIQUID SUPERPOSITION APPROXIMATION. G.H.A.Cole.
Proc. Phys. Soc., Vol. 73, Pt 5, 713-20 (May, 1959).

A procedure involving a coupling parameter is described by which the pair distribution for a classical condensed system of particles can be calculated without the need for applying the superposition approximation to the triplet distribution itself, although it is still needed for the higher order distributions. For the special case of spherical particles interacting with central forces the approach takes on its simplest form and should provide a feasible means of deriving highly accurate information about the structure of a simple classical liquid under uniform conditions. An extension of the method is suggested for completeness by which all the lower order distribution functions can in principle be successively released from the restrictions of the superposition approximation.

532.7

6592. VISCOSITY AND SELF-DIFFUSION IN LIQUIDS. E.McLaughlin.
Trans Faraday Soc., Vol. 55, Pt I, 28-38 (Jan., 1959).

A modified rate-theory approach to the calculation of the transport coefficients of a liquid composed of spherically symmetric molecules has been developed. On the model proposed the existence of holes is a necessary requirement for the transport of mass and momentum to take place. The theory permits calculation of the transport coefficients from one experimental parameter, the molar volume of the liquid, provided the force constants of the molecular interaction derived from the transport properties of the corresponding gases are known. Calculated values of the coefficients of viscosity and self-diffusion for some simple spherical and pseudo-spherically symmetric molecules agree to within approximately 10% of the experimental values.

532.71

6593. OSMOTIC ELECTRIC OR MAGNETIC FIELD. T.L.Hill.
J. chem. Phys., Vol. 29, No. 6, 1419 (Dec., 1958).

The chemical potential of the solvent alters much more slowly with change in electric or magnetic fields than with change in pressure, and an outline is given of the theoretical treatment for two schemes which could in principle be used to determine high molecular weights. R.F.Barrow

532.71

6594. OSMOTIC ELECTRIC OF MAGNETIC FIELD. T.L.Hill.
J. chem. Phys., Vol. 30, No. 5, 1161-5 (May, 1959).

The usual osmotic pressure method for the determination of molecular weights becomes inaccurate when applied to solutes with high molecular weights because the solvent chemical potential is too sensitive to pressure changes. Since the solvent chemical potential is much less sensitive to changes in electric or magnetic field, the suggestion is made that these variables might be useful in osmotic experiments. A few schematic arrangements and a numerical example are discussed. Any possible advantage of the proposed method, over the conventional osmotic pressure method, rests on the replacement of a measurement of a small pressure difference by the measurement of a sizable electric or magnetic field coupled with a null observation on the pressure difference.

532.72

6595. NEW METHOD OF DETERMINING THE SORET COEFFICIENTS. T.Ikeda.
J. chem. Phys., Vol. 30, No. 1, 345-6 (Jan., 1959).

The method is in principle applicable to all electrolytes that, with appropriate reversible electrodes, constitute thermocells. The initial thermoelectric power of such a cell is shown to be related to the Soret coefficient, the mean activity coefficient of the electrolyte and the entropies of the electrode materials and of electrons in the metallic phase. W.Good

532.72

6596. DIFFUSION IN ETHYLENE POLYMERS. IV.
D.W.McCall, D.C.Douglass and E.W.Anderson.
J. chem. Phys., Vol. 30, No. 3, 771-3 (March, 1959).

For Pt III, see J.Amer. Chem. Soc., Vol. 80, No. 8, 1861 (1958). Self-diffusion coefficients were measured for two low molecular weight fractions (M = 4100 and 5800) of a linear polyethylene. The activation energy for the M = 4100 fraction is 5.3 kcal/mole, which is near the value 5.6 kcal/mole found for n–$C_{32}H_{66}$. At 150° C, for this fraction, $D = 1.6 \times 10^{-7}$ cm^2/sec and as 10^{-7} is near the lower limit of detectability the activation energy is probably not accurately determined. The diffusion coefficient for the M = 5800 fraction is 1.1×10^{-7} cm^2/sec at 150° C. These results, combined with previous results, show that $D = \kappa n^{-5/3}$, where D is the coefficient of self-diffusion for the normal paraffin C_nH_{2n+2}. κ is a constant at a given temperature, 4.5×10^{-3} cm^2/sec at 200°C and 2.5×10^{-3} cm^2/sec at 150° C.

532.72 : 530.162

6597. STATISTICAL MECHANICAL THEORY OF THERMAL DIFFUSION IN BINARY LIQUID SOLUTIONS. R.J.Bearman.
J. chem. Phys., Vol. 30, No. 1, 835-8 (March, 1959).

The statistical mechanical theory of thermal diffusion in binary solutions is developed from the point of view of the pair space linear relations which have been used previously to derive theories of the heat of transport and thermal conductivity. The thermal diffusion factor is obtained in terms of statistical mechanical averages over the equilibrium radial distribution functions, and when assumptions of the theory of regular solutions are introduced into the general expression, one finds that it is related to the molar volumes, thermal expansion coefficients and compressibility coefficients of the pure components and to the self-diffusion coefficients in the mixture.

532.73 : 541.132

6598. ENERGIES INVOLVED IN REORIENTING HYDRATION SHELLS OF IONS. W.L.Reynolds.
J. chem. Phys., Vol. 29, No. 4, 851-5 (Oct., 1958).

Free energies for reorientation of solvent molecules about ions were calculated using Marcus' equation (Abstr. 4712/1956) for the electrostatic potential and compared with values derived from charge transfer spectra. The low values obtained suggest that electron tunnelling between fully hydrated ions is a feasible mechanism contrary to the conclusions of Platzman and Franck (Abstr. 9073/1954).

532.73

6599. BROWNIAN MOTION IN THE CENTRIFUGAL FIELD.
M.Gehatia and E.Katchalski.
J. chem. Phys., Vol. 30, No. 5, 1334-9 (May, 1959).

The combined sedimentation and diffusion process of macromolecules in the centrifugal field was considered phenomenologically. For each dissolved particle a stochastic equation is estimated composed of two independent velocities: a diffusional and a sedimentational. With the help of the "central limit theorem with Lindeberg conditions" the formula for the distribution of the particles in an ultracentrifugal cell was derived. A transformation was found which converts the equations of diffusion alone in the formulae of diffusion in a centrifugal field. The expressions for concentrations in rectangular and sectorial cells can be easily tabulated; they solve the corresponding equations of continuity and fulfil the principle of conservation of amount of dissolved particles in the cell. With help of these formulae the sedimentation constant as well as the diffusion constant can be evaluated from the form of the experimental sedimentation curve.

532.74 : 539.213

STRUCTURE OF MOLTEN Se. See Abstr. 6296

532.77 : 539.219

6600. PROPERTIES OF SOLID AND LIQUID SOLUTIONS OF ARGON AND KRYPTON. R.Heastie.
Proc. Phys. Soc., Vol. 73, Pt 3, 490-500 (March, 1959).

The vapour pressure P of solid and liquid mixtures of argon and krypton of a number of different compositions has been measured over a temperature (T) range which includes the "melting" and "freezing" points of the mixtures. The solid–liquid phase-equilibrium diagram has been deduced by observation of discontinuities in slope of (log P, 1/T) graphs. The measurements show that argon and krypton are completely soluble in the liquid and solid states and that the solid solutions exhibit a positive deviation from ideality. The solid solution data are compared with theory. Although the experimental results are not in complete agreement with any of the theories considered, the cell theory predicts approximately the observed magnitude of the deviations from ideality of the vapour pressure.

532.771 : 534.23

TERTIARY BUTANOL COMPLEX FORMATION IN DILUTE SOLUTIONS IN CYCLOHEXANE. See Abstr. 5453

MECHANICS OF GASES
VACUUM TECHNIQUE

533.15

6601. MUTUAL DIFFUSION OF PAIRS OF RARE GASES AT DIFFERENT TEMPERATURES. B.N.Srivastava and K.P.Srivastava.
J. chem. Phys., Vol. 30, No. 4, 984-90 (April, 1959).

The coefficient of mutual diffusion of the binary gas mixtures Ne–A, A–Kr, and Ne–Kr was determined at 0°, 15°, 30°, and 45° C. Diffusion was allowed to take place between two diffusion bulbs through a precision capillary tube and samples of gas were withdrawn from one bulb at different times and analysed by a differential conductivity analyser. From the experimentally determined values of the diffusion coefficient at different temperatures the unlike interaction parameters for the above gas pairs were calculated by two different methods on the Lennard-Jones 12:6 model. These values of the force parameters are found to be in good agreement with those obtained from the usual combination rules and also from the thermal diffusion data following the method of Srivastava and Madan. These values are found to reproduce the experimental data on mutual diffusion quite satisfactorily. With Kelvin's method, these data have also been utilized to calculate the self-diffusion coefficient of neon, argon, and krypton.

533.15

6602. COMPOSITION DEPENDENCE OF THE DIFFUSION COEFFICIENT OF THE SYSTEM A–Xe. I.Amdur and T.F.Schatzki.
J. chem. Phys., Vol. 29, No. 6, 1425-6 (Dec., 1958).

Earlier measurements (Abstr. 2860/1958) on the diffusion of inert xenon containing a trace of A^{37} into inert xenon are compared with the present measurements on the diffusion of inert argon containing a trace of Xe^{131} into inert argon. A slightly higher value of the diffusion coefficient (0.7%) is predicted from theory for the case when the mole fraction x_{Xe} is equal to one. The measured values of the diffusion coefficients show no dependence on composition within experimental accuracy (1%). H.C.Cole

533.15 : 539.18

6603. THE SEPARATION JET. II. THE PHYSICAL BASIS OF THE SEPARATING EFFECT AND THE SPECIFIC COST OF THE PROCESS.
E.W.Becker, W.Beyrich, K.Bier, H.Burghoff and F.Zigan.
Z. Naturforsch., Vol. 12a, No. 8, 609-21 (1957). In German.

In an earlier paper (Abstr. 9838/1955) the influence of jet form and gas pressure on the separation efficiency was examined for A^{36}/A^{40} mixtures. It was shown that the essential characteristics of the separation effect can be explained by a combination of pressur diffusion and ordinary diffusion. In this section II the specific cost at the most favourable working conditions in a separation cascade is ascertained. The case of a plant using UF_6 as a working gas is considered in detail and it is shown that the separation jet process provides an economical method for the separation of the uranium isotopes. H.C.Cole

533.16

6604. CAPILLARY VISCOMETER FOR INERT GASES AND VAPORS AT HIGH TEMPERATURES AND PRESSURES.

J.M.Savino and W.L.Sibbitt.

Industr. engng Chem., Vol. 51, No. 4, 551-4 (April, 1959).

A coiled capillary viscometer for testing inert gases, vapours, and mixtures up to 815°C and 510 atm was successfully calibrated and tested with nitrogen and carbon dioxide at 25°C and pressures to 270 and 48 atm, respectively.

533.5 : 531.788.1

6605. NOVEL METHOD FOR VACUUM MEASUREMENT: THE ELECTROACOUSTIC VACUUM GAUGE.

V.G.Neaga and V.I.Antonescu.

An. Stiint, Univ. "Al. I. Cuza", Iasi I (Ser. noua), Vol. 3, No. 1-2, 281-6 (1957). In Roumanian.

Developed for the range 760 to 5 mm Hg, this method is based on the relation between the attenuation of a sound wave, in a given gas, and the pressure. A transducer is described for generating plane sound waves at 50 c/s: the receiver is a crystal microphone. Circuit details and a calibration, with its theoretical derivation, are given. A.Reiss

533.5 : 531.788.7

6606. INITIAL PUMPING AND RECOVERY OF IONIZATION GAUGES.

N.W.Robinson and F.Berz.

Vacuum, Vol. 9, No. 1, 48-53 (March, 1959).

Measurements were made on the pressure decrease in a closed glass system when an ion gauge pumps, and also of the recovery of pressure when pumping is stopped after a short period. The pressure decrease may be represented by an equation of the type

$$p - p_1 = C_1 e^{-a_1 t} + C_2 e^{-a_2 t},$$

where p and p_1 are the pressure after any time t and the "final" pressure, respectively. C_1, C_2, a_1, a_2 are parameters depending upon the nature of the gas and surfaces. For pumping a_1 and a_2 contain terms depending upon the electron current. For recovery a_1 is determined by the sticking time of pumped molecules on the glass and a_2 by a glass characteristic. Average sticking times are found to increase from about 10 to 2000 sec as the temperature of the system increases from 22° to 450°C with consequent change in heats of adsorption from 18 to 40 kcal/mole approximately. The increase in sticking times are attributed to changes in residual gas composition.

533.5 : 537.54

6607. [DEVELOPMENT OF] VACUUM SYSTEM FOR A THIRTY BILLION ELECTRON VOLT PARTICLE ACCELERATOR.

C.L.Gould.

Vacuum, Vol. 9, No. 1, 63-8 (March, 1959).

The vacuum chamber is a torus one-half mile in circumference with a cross-section of 3 in. by 7 in. Approximately fifty getter-ion type pumps will be used on the ring to give the required pressure of 2×10^{-6} mm Hg. A linear accelerator yielding 50 MeV protons will be used as the injector. The vacuum chamber of this accelerator is 110 ft long and 3 ft in diameter. It will be evacuated to 1×10^{-6} mm Hg by eleven getter-ion pumps. The choice of getter-ion pumps has permitted a departure from conventional vacuum system design and operation. Details of some new concepts of initial evacuation, steady state operation, and simplicity of control of a system of this nature are given.

533.56

6608. THE PRODUCTION OF ULTRA-HIGH VACUA BY MEANS OF A DIFFUSION PUMP.

A.Venema.

Vacuum, Vol. 9, No. 1, 54-7 (March, 1959).

The result of a measurement of the so-called ultimate pressure of a diffusion pump is often not only determined by the pump itself, but also by the additional apparatus necessary for making this measurement. An analysis is given of the gases which may be present at the pump mouth and the factors determining the pressure of these gases are treated. A discussion of the methods which can be used for making these pressures as small as possible results in a design of a pump apparatus. A description of this apparatus, which includes a mercury diffusion pump with cooling traps, is given. With the apparatus a pump speed at the recipient of 5-10 litres/sec for the common gases is obtained and an ultimate pressure lower than 10^{-12} mm Hg reached.

533.58

6609. REMOVAL OF GASES IN HIGH VACUUM SYSTEMS BY METAL ABRASION.

M.E.Haine, E.W.R.Francis and R.N.Bloomer.

Nature (London), Vol. 182, 931-2 (Oct. 4, 1958).

The action of a getter may cease after a short time due to the formation of a protective oxide film. This difficulty can be overcome by evaporating fresh layers continuously. This is difficult since it involves handling a reactive metal above its melting point. An alternative is to scrape the surface clean; a suitable technique is described. Such getter pumps enable low pressures to be maintained provided auxiliary means are provided for disposing of argon which is, of course, not pumped by the getter. T.Mulvey

533.59

6610. A NEW METHOD OF DETERMINING A FIGURE OF MERIT FOR VACUUM-PUMP OIL.

O.Herrmann.

Tech. wiss. Abhandl. Osram-Gesell., Vol. 7, 369-75 (1958). In German.

An electric lamp bulb is used on the pumps as a Pirani gauge to assess the pressure of oil and other vapours that occur in mechanical pumps used for evacuating such bulbs. T.Mulvey

533.59

6611. QUICK-OPERATING ELECTRODYNAMIC VACUUM VALVE.

I.S.Shpigel'.

Pribory i Tekh. eksper., 1959, No. 1, 151 (Jan.-Feb.). In Russian.

Details are given of a vacuum valve working on the principle of electrodynamic interaction between the current in a coil surrounding the inlet to the vacuum chamber, and induced eddy currents in the metal disk which closes the inlet. J.M.Zarzycki

533.6 : 531.758

6612. ELECTRON BEAM DENSITY PROBE FOR MEASUREMENTS IN RAREFIED GAS FLOWS.

F.C.Hurlbut.

J. appl. Phys., Vol. 30, No. 3, 273-9 (March, 1959).

The instrument utilizes the attenuation of an electron beam. The beam in passage through a rarefied gas becomes scattered in a number of elastic and inelastic processes, and decays to a fraction of its initial intensity in the distance of a few electron mean free paths. Where the optical aperture of the detector is suitably small, the familiar linear absorption law applies. The mass absorption coefficient in this case is higher and more favourable for work at the lowest test section densities than in other absorption techniques investigated up to the present. The instrument was used in an investigation of air flows about a sphere and a wedge, and in the undisturbed stream. The flow was maintained constant for all portions of the test at Mach 1.95, Re/in. ~200, test section static pressure ~80 μ Hg. Plots of the original and the reduced data show adequate internal consistency and a qualitative conformity with expected configurations.

533.6 : 523.51

TRANSITIONAL AERODYNAMIC DRAG OF METEORITES.

See Abstr. 6450

533.6.011.3

6613. VARIATIONS IN THE VALUE OF REYNOLDS NUMBER AT THE TRANSITION FROM STREAMLINE TO TURBULENT FLOW.

P.J.Isaac, I.B.Williams and W.M.Jones.

Nature (London), Vol. 183, 531-2 (Feb. 21, 1959).

Appreciable variations of the critical Reynolds number for the onset of turbulence are reported in flow at pressures of 2—80 atm of different gases (N_2 and CO_2) through (i) a porous Cu disc and (ii) a long Cu tube. J.G.Oldroyd

533.6.011.3 : 534.213.4

AXIALLY-SYMMETRICAL ACOUSTIC STREAMING AT THE WALLS OF A CYLINDER.

See Abstr. 5436

533.6.011.311

6614. SUCTION OF THE BOUNDARY-LAYER FLOW ALONG A HOT PLATE AS A MEANS OF SEPARATING GAS MIXTURES.

V.C.Liu.

J. chem. Phys., Vol. 29, No. 4, 967-8 (Oct., 1958).

When a mixture of gases flows along a flat plate a thin, laminar, high temperature gradient boundary layer is produced, with the thermal gradient dependent upon the temperature difference between the plate and the free-stream gases and on the flow and gas parameters. If the gas is made up of a mixture of unequal molecular

weights, the thermal diffusion flux causes a concentration of the lighter gas at the plate, and suction at the plate allows the enriched light mixture to be collected. The theory of diffusive separation, based on the asymptotic temperature and velocity profiles leads to an expression for the enrichment factor, based on the hypergeometric function. The usual assumptions of boundary layer theory are made, together with that of uniform suction. The possible contribution to mixture separation by the capillary effect through a porous wall is not included; it is clear, however, that the method cannot compare with the diffusion column from the economic point of view.
P.G.Morgan

MOLECULAR THEORY OF GASES

533.7

6615. COLLISIONAL RELAXATION IN GASES. N.J.Phillips.
Proc. Phys. Soc., Vol. 73, Pt 5, 800-6 (May, 1959).

Solutions of the time-dependent Boltzmann equation for gases are considered. The Boltzmann equation is first linearized by considering only small deviations from equilibrium. From the solutions of the linearized equation, a variational principle is developed, which permits the estimation of the eigenvalues by a method of successive approximations. In this paper the lowest non-zero characteristic rate of relaxation for spherically symmetrical distributions is calculated. The distribution function is assumed to be uniform in the configuration space. Eigenvalues have been evaluated for gases whose particles interact with a law of force of the form $Q(a/r)^s$ where r is the distance between a pair of particles. The cases $s = 2$, 5 and infinity have been considered in detail. In the cases $s = 2$, the impact parameter is cut off at the Debye shielding distance. The calculations are extended to include the case of a two-component mixture of gases.

533.7 : 536.422.1

FREE EVAPORATION OF ALKALI HALIDE CRYSTALS. See Abstr. 5623

533.7 : 530.162

TRANSPORT PHENOMENA IN A FLUID COMPOSED OF DIATOMIC MOLECULES. See Abstr. 6549

533.72

6616. NOTE CONCERNING CERTAIN INTEGRALS IN THE KINETIC THEORY OF GASES. J.Friedrich.
Tech. wiss. Abhandl. Osram-Gesell., Vol. 7, 22-6 (1958).
In German.

The integrand is originally given in terms of the Cartesian velocity components. It is transformed to spherical polar coordinates and the angular integration is performed explicitly.
R.Eisenschitz

533.72 : 541.124

6617. THE CONSERVATION EQUATIONS FOR INDEPENDENT COEXISTENT CONTINUA AND FOR MULTICOMPONENT REACTING GAS MIXTURES. W.Nachbar, F.Williams and S.S.Penner.
Quart. appl. Math., Vol. 17, No. 1, 43-54 (April, 1959).

The equations for conservation of mass, momentum, and energy are derived for a set of independent, coexistent continua obeying the laws of dynamics and thermodynamics. The idea of a control volume and a control surface for each continuum is used in the analysis. The derived results are practically identical with relations obtained previously by von Kármán. A direct comparison is made between the continuum theory results and those obtained from kinetic theory by assuming that, for each of the species, the kinetic theory definitions apply. It is found that the new terms appearing in the conservation equations derived from continuum theory are precisely those which are required to make these equations identical with the results obtained from the kinetic theory of multicomponent, reacting gas mixtures. However, the continuum theory forms of the equations are not useful because they require knowledge of the transport properties for individual species in the mixture.

533.72 : 536.24

HEAT PHENOMENA ON ROTATING BODIES IN FREE MOLECULE FLOW. See Abstr. 5612

VIBRATIONS . ACOUSTICS

534.114

6618. THEORETICAL AND EXPERIMENTAL STUDY OF TUNING FORKS WITH THIN TINES. R.Chaleat.
Ann. Franc. Chronom., Vol. 13, No. 1, 1-22 (1959). In French.

A theoretical expression, giving results in close agreement with observed values, is derived for the frequency of a U-shaped tuning fork having tines of small cross-sectional area. This takes the form of $f = (k\sqrt{E/\delta})e/R^2$, where E and δ are respectively the Young's Modulus and density of the material, e is the thickness of the tines, R is the radius of curvature of the U and k is a constant dependent on R and the length of the tines. A table of values of k and a nomogram are given for obtaining the frequency of forks of different dimensions and materials.
H.J.H.Starks

534.133 : 539.32

6619. MECHANICAL RESONANCE DISPERSION IN SINGLE CRYSTALS. E.R.Fitzgerald.
Phys. Rev., Vol. 112, No. 4, 1063-75 (Nov. 15, 1958).

Single crystals of sodium chloride, copper sulphate, and Rochelle salt exhibit sharp resonance dispersions in dynamic shear compliance in the range from 100 to 5000 c/s. The resonances are similar to those previously reported for polycrystalline metals, crystalline polymers, fused quartz, and single crystals of quartz. The data can be analysed and fitted closely by means of a generalized stress—strain relation involving a linear combination of the strain and its first and second time derivatives. Inclusion of the third derivative leads to an anti-dissipative term which can be used to account qualitatively for a negative absorption or induced emission observed over a narrow frequency range in sodium chloride. The negative absorption seems to be connected with static clamping stresses applied to the sample, decreases slowly with time, and can be reactivated by restressing. The results in general are consistent with a tentative explanation which assumes the resonances correspond to exchange frequencies for energy passing back and forth among only a few of the available modes of vibration of the crystal lattice.

534.134

6620. INEXTENSIONAL VIBRATIONS OF A SPHERE—CONE SHELL COMBINATION. H.Saunders and P.R.Paslay.
J. Acoust. Soc. Amer., Vol. 31, No. 5, 579-83 (May, 1959).

The Rayleigh inextensional theory for thin shells is employed to predict the natural frequencies of a sphere—cone combination. For a particular case, the calculated and measured natural frequencies of shells of nonuniform thickness are determined. In comparing the experimental values of the lowest five "bell" frequencies with the predicted theoretical inextensional theory, there is very good agreement. This indicates that the method may be used for many missile configuration and jet engine applications.

534.2

6621. SCATTERING OF COMPRESSION WAVES BY SPHERICAL OBSTACLES. L.Knopoff.
Geophysics, Vol. 24, No. 1, 30-9 (Feb., 1959).

The scattering of plane P waves by a spherical obstacle is formulated. A calculation is given for the special case of scattering by a perfectly rigid sphere in which the medium outside has a Poisson's ratio of $\frac{1}{4}$. The range of sizes of obstacles used in the calculation includes radii very small compared with wavelength and radii comparable to the wavelength. For incident P waves, scattered P and S are computed with shifts in time phase occurring in both with respect to the incident beam. For small obstacles, the scattered S wave is generally broadside to the scattered P-wave beam.

534.2 : 539.386

6622. SCATTERING OF SHEAR WAVES BY SPHERICAL OBSTACLES. L.Knopoff.
Geophysics, Vol. 24, No. 2, 209-19 (April, 1959).

The problem of the scattering of plane S-waves by a perfectly rigid, infinitely dense sphere is formulated. Calculations are made for the case in which the medium outside the sphere has a Poisson's ratio of $\frac{1}{4}$. The range of sizes of obstacles used in the calculation includes radii very small compared with the wavelength and radii comparable to the wavelength. The scattered wave motions include a P-mode and two S-modes. One of the S-modes has a formal correspondence to the SH-mode of plane seismology; the other corresponds to the SV-mode. At large distances from the obstacle the scattered P- and S- fields are computed together with the phase shifts in time occurring in all the components. For small obstacles, the scattered azimuthal S-component is circularly symmetric; the scattered meridional S-component diffraction pattern is generally elongated in the direction of propagation; the scattered P-component is generally broadside to the direction of propagation.

534.2

6623. THE PROPAGATION OF INFINITESIMAL PLANE WAVES IN ELASTIC—PLASTIC MATERIALS. J.W.Craggs.

J. Mech. Phys. Solids, Vol. 5, No. 2, 115-24 (March, 1957).

The propagation of small discontinuities of stress is examined. It is shown that plane waves of two types may exist, each involving both dilatation and shear strain, and an equation for the velocities of such waves is given. Possible interactions between plastic (loading) waves and elastic (unloading) waves are discussed and the treatment of such interactions is illustrated.

534.2

6624. EFFECT OF THERMAL PROPERTIES OF A SOLID ON THE VELOCITY OF RAYLEIGH WAVES. F.J.Lockett.

J. Mech. Phys. Solids, Vol. 7, No. 1, 71-5 (Nov., 1958).

Concerned with the propagation of Rayleigh waves in an isotropic thermoelastic solid. It is found that, within the frequency range normally attainable, the velocity of propagation of these waves can be determined from the classical equation merely by replacing the parameter $\beta^2 = (\lambda + 2\mu)/\mu$ occurring in that equation by $(1 + \epsilon)\beta^2$, where $\epsilon = \gamma^2 v_p^2 (1 + \nu)^2 / c(1 - \nu)^2$ where γ is the coefficient of linear expansion, v_p is the velocity of purely elastic longitudinal waves in the solid, T is the absolute temperature of the solid in its reference state of uniformly zero stress and strain, c is the specific heat at constant strain and ν is Poisson's ratio. A typical case is examined numerically and it is found that taking into account the thermal properties of the solid produces a difference of less than one per cent in the velocity and amplitude of the Rayleigh waves.

534.2

6625. PROPAGATION OF FINITE ELASTIC WAVES IN RUBBER. P.Mason.

Nature (London), Vol. 183, 812-13 (March 21, 1959).

High-speed cinematograph pictures of a finite pulse of unloading (from 300% extension) in a rubber strip suddenly released from one end confirm that the specimen at any instant consists of two parts sharply divided by the head of the pulse: one stationary at the original extension, the other completely relaxed and moving as a rigid body. The pulse velocity agrees well with that of infinitesimal waves at the original extension, in natural and in butyl rubbers, but the absence of dispersion is difficult to explain. J.G.Oldroyd

534.2 : 539.374

PROPAGATION OF DYNAMIC STRESSES IN VISCO-ELASTIC RODS. See Abstr. 6328

534.21 : 538.566

6626. ON PROPAGATION OF WAVES IN SLIGHTLY ROUGH DUCTS. J.C.Samuels.

J. Acoust. Soc. Amer., Vol. 31, No. 3, 319-25 (March, 1959).

The problem of the propagation of harmonic signals in a slightly rough duct is investigated. The analysis is made tractable by the assumption that the heights of the roughness peaks are small compared to the average separation of the duct walls. Both acoustic and electromagnetic waves are treated. In the case of a duct with harmonic roughness, it is found that waves are not scattered upstream if the frequency of the transmitted signal exceeds certain critical values related to the natural modes of the wave guide and the wavelengths of the wall roughness. It is also found that the scattered signals are amplified whenever the frequency of the transmitted signal is equal to any of a series of critical frequencies determined by the natural modes of the guide and the spectrum of the wall roughness. Statistically rough walls are also treated, and specific results worked out for roughness functions having Dirac delta function correlation or exponential correlation.

534.21 : 539.374

6627. PROPAGATION OF PLASTIC WAVES IN SOLIDS. J.F.Bell.

J. appl. Phys., Vol. 30, No. 2, 196-201 (Feb., 1959).

A detailed experimental study of large amplitude plastic waves in annealed aluminium is presented. Using the author's diffraction grating technique, accurate strain—time and surface angle—time histories were obtained at different locations in the vicinity of impact. Verification of the strain-rate independent theory with strain amplitude modifications is provided in this region for impact velocities up to 63 ft/sec. Poisson's ratio is dynamically determined for strains up to 1.5%. Marked changes are observed in the propagation behaviour above 1.06% strain, related to the abrupt increase of Poisson's ratio from $\frac{1}{3}$. The maximum amplitude of waves above this value decreases exponentially with distance from impact.

534.21

6628. ULTRASONIC WAVE PROPAGATION IN A NICKEL SINGLE CRYSTAL. J.de Klerk.

Proc. Phys. Soc., Vol. 73, Pt 3, 337-44 (March, 1959).

The propagation of ultrasonic energy in a nickel single crystal by an improved pulse technique has been employed to investigate the behaviour of the dynamic elastic constants of, and the energy losses in the specimen, with and without an applied magnetic field. The dynamic elastic constants behave according to Zener's theory of anelasticity in the test range of frequencies. Values of the relaxation time for internal atomic rearrangement and ratios of the relaxation strengths for shear and compressional waves are evaluated for the sample. Energy losses are substantially reduced when the sample is magnetized to saturation.

534.21 : 538.566

6629. GUIDED PROPAGATION IN A SLOWLY VARYING MEDIUM. D.E.Weston.

Proc. Phys. Soc., Vol. 73, Pt 3, 365-84 (March, 1959).

Some simple formulae are derived, which are useful in investigating wave propagation in a variable stratified medium. It is shown that the rays in a two-dimensional medium with slowly varying thickness and structure may be described by a characteristic time. From this time the ray angles at any horizontal position may be calculated. The characteristic time formula is also derived from considerations of normal modes, and then from considerations of energy flux. The formula still applies when there are slow bends or twists in the medium, with no limits on final amplitude. The extension to three-dimensional guides is discussed. Some formulae for intensity in slowly varying media are also obtained. The ideas are applied to the propagation of sound (especially underwater), shear wave, and electromagnetic radiation, and the present limitations of the method indicated.

534.21 : 532.7

ON THE DERIVATION OF REACTION PARAMETERS FROM OBSERVATIONS OF ULTRASONIC RELAXATION. See Abstr. 6590

534.22 : 539.32

6630. MEASUREMENT OF ULTRASONIC WAVE VELOCITIES AND ELASTIC MODULI FOR SMALL SOLID SPECIMENS AT HIGH TEMPERATURES. H.J.McSkimin.

J. Acoust. Soc. Amer., Vol. 31, No. 3, 287-95 (March, 1959).

An improved buffer rod-specimen unit is described for measuring longitudinal wave velocities in solids at temperatures up to 350°C. The method is particularly useful in determining elastic moduli of single crystals since very small path lengths in any prescribed direction can be employed. The use of molten metals to provide coupling at still higher temperatures is discussed. Two methods involving mode conversion at in impedance discontinuity are described for measuring shear wave velocities. Application to crystals of cubic symmetry is detailed, with a note on possible extension to less symmetrical crystals of any orientation. Data for fused silica and single crystal germanium are listed for temperatures up to 300°C in illustration of the methods described.

534.221

6631. STUDY OF TEMPERATURE VARIATION OF ULTRASONIC VELOCITIES IN SOME ORGANIC LIQUIDS BY MODIFIED FIXED-PATH INTERFEROMETER METHOD.

K.Subba Rao and B.Ramachandra Rao.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 439-41 (April, 1959).

A simple, rapid, and accurate method of determining temperature coefficient of ultrasonic velocity in liquids is presented. The method is based on a modification of the fixed-path double-crystal interferometer. Temperature variation of ultrasonic velocity in a few organic liquids was studied by employing this method.

534.221

6632. VELOCITY AND ATTENUATION OF A NARROW-BAND, HIGH-FREQUENCY COMPRESSIONAL PULSE IN A SOLID WAVE GUIDE. M.Redwood.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 442-8 (April, 1959).

The usual solutions describing the propagation of continuous waves in solid plates and cylinders fail to predict the observed velocity and attenuation, and secondary signals, in the propagation of a narrow-band pulse of compressional waves of carrier frequency of the order of 10 Mc/s. It is shown that all these factors may be accounted for if a slightly different form of solution is chosen, to fit more closely the conditions under which the propagation takes place. Both plates and cylinders are treated theoretically, and methods of obtaining approximate solutions of the modified frequency equations are discussed. The results of this analysis agree closely with those derived by other, less exact methods, which commence with the assumption that the solid medium behaves very similarly to a fluid. The relation of this work to the propagation of pulses at low frequencies is also discussed. A method of analysis similar to that employed here is also necessary to predict experimental results in the propagation of pulses in multilayered waveguides of any configuration, mechanical or electromagnetic.

534.222.2

6633. SHOCK WAVE IN A NON-MONATOMIC FLUID. P.Théodoridès.

Helv. phys. Acta, Vol. 31, No. 1, 33-42 (1958). In French.

With atomic vibration representing the intramolecular processes of non-monatomic fluids, the structure of a normal shock wave is analysed. Conservation equations of mass, momentum and energy are set on trimerous viscosity, and specialized for a uniaxial steady flow taken initially as supersonic under stratospheric conditions ($T_1 = 218^\circ$K, $p_1 = 0.1$ atm). For a normal shock of varied strength, boundary conditions are calculated for variable enthalpy. The temperature dependency of all the parameters is based on N.B.S. Tables (1955). Numerical results are given for molecular nitrogen. With reference to Becker's classical figures on air of constant Prandtl-number, it is shown that temperature effects would increase his shock thickness about tenfold in the velocity profile, and an increase in the broadening of about 42% is found.

534.222.2

6634. FINITE-AMPLITUDE PROPAGATION EFFECT ON SHOCK-WAVE TRAVEL TIMES FROM EXPLOSIONS AT HIGH ALTITUDES. J.Otterman.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 470-4 (April, 1959).

A method is described for calculating the effect of the finite-amplitude propagation on the travel times of pressure waves from explosions at high altitudes to the ground. Numerical results are presented for explosions of 2-lb and 4-lb H.E. charges at altitudes ranging from 15 to 95 km. Vertical propagation is assumed in the calculations. This work was carried out in order to improve the systematic accuracy of the rocket grenade experiment for upper atmosphere temperature and winds. The significance of the finite-amplitude propagation in this experiment is discussed.

534.222.2

6635. SOME CHARACTERISTICS OF LONG-RANGE EXPLOSIVE SOUND PROPAGATION. T.Arase.

J. Acoust. Soc. Amer., Vol. 31, No. 5, 588-95 (May, 1959).

A brief discussion is given, in terms of ray theory, of the character of explosive sound which has propagated for long distances in the ocean. In addition to the arrivals previously studied, a "leakage" arrival was observed. This arrival was analysed for travel time and spectrum level. The attenuation rate was plotted as a function of frequency. The similarity of this attenuation rate to the theoretical and experimental attenuation rates for the surface channel indicates that the leakage arrival is due to energy that in part travels in the surface channel and in part is refracted.

534.222.2

6636. TRIPLE-SHOCK-WAVE INTERSECTIONS. J.Sternberg.

Phys. of Fluids, Vol. 2, No. 2, 179-206 (March-April, 1959).

In the Mach reflection of weak shock waves, there has been a wide difference between theory and experiment for the shock wave angles at the triple point. Using the electric tank analogy in the hodograph to obtain the shock patterns it is found that the shock waves are so strongly curved near the intersection that the triple point angles cannot be observed in the laboratory. However, it is shown that the visible shock patterns are apparently inconsistent with the hodograph boundaries specified by the existing triple point theory. The effect of shock wave thickness on the boundary conditions at the triple point is then examined. It is shown that at the intersection there must be a non-Rankine–Hugoniot shock wave zone separating the three R–H shock waves. It follows that for weak shock waves where the shock curvatures → ∞ at the triple point, the simple boundary conditions of equal pressure and direction are invalid for a real fluid. A semiquantitative description is then given of a real fluid model which is consistent with the experimental data and with the Navier–Stokes equations. The examination of this model reveals the formidable difficulties in the way of obtaining a detailed mathematical description of a triple shock wave intersection in a real fluid. The question of the solution for the limiting case as $\mu \to 0$ is also discussed.

534.222.2

6637. SHOCK-TUBE PERFORMANCE AT LOW INITIAL PRESSURE. R.E.Duff.

Phys. of Fluids, Vol. 2, No. 2, 207-16 (March-April, 1959).

An electron beam densitometer was used to investigate the behaviour of a conventional $1\frac{1}{8}$ in. i.d. shock tube operating at initial pressures of the order of 1 mm Hg. These experiments show that such a shock tube does not perform as predicted by simple theory. Most of the experiments were performed in argon with shock Mach numbers ranging between 1.2 and 7.0. The most striking observation was that for a given shock velocity, $M_s = 1.6$, the distance between the shock wave and contact surface as observed at the densitometer was proportional to initial pressure and independent of expansion chamber length over a tenfold range of tube length. At an initial pressure of 0.5 mm Hg the time interval between the arrival of the shock and the contact surface varied between 600 μsec at $M_s = 1.2$ and 20 μsec at $M_s = 7.0$. The diaphragm pressure ratio $(A_r - A_r)$ required to produce a shock of velocity $M_s = 1.6$ varied from 200 at an initial pressure of 0.25 mm Hg to 20 at an initial pressure of 50 mm Hg. For a given diaphragm pressure ratio the shock velocity decreased with distance in a highly nonlinear manner. The density behind the shock wave was observed to increase significantly before the arrival of the contact surface under all conditions. This surprising shock-tube behaviour is believed to be related to severe laminar boundary layer development behind the shock wave at low initial pressure.

534.222.2

6638. BLAST WAVE FROM A SPHERICAL CHARGE. H.L.Brode.

Phys. of Fluids, Vol. 2, No. 2, 217-29 (March-April, 1959).

The blast wave from the detonation of a spherical charge of T.N.T. is described based on results of a numerical calculation. The equations of motion and the equations of state for T.N.T. and for air are described. The pressures, densities, temperatures, and velocities are detailed as functions of time and radius. Space-time relations and energy and impulse histories are shown. A second shock is seen to originate as an imploding shock following the inward rarefaction into the explosion product gases and a series of subsequent minor shocks are seen to appear in a similar manner, moving out in the negative phase behind the main shock.

534.222.2

6639. THE THICKNESS OF CYLINDRICAL SHOCKS AND THE PLK METHOD. H.C.Levey.

Quart. appl. Math., Vol. 17, No. 1, 77-93 (April, 1959).

Cylindrical shocks occur when a viscous heat-conducting gas flows radially in a plane. This is a singular perturbation problem in which the perturbing parameter is the reciprocal of R_e, the Reynolds number of the flow. It is shown that for both inward facing shocks (source flow) and outward facing shocks (sink flow) the shock thickness is of order $R_e^{-1}S^{-1} \log (R_e S^3)$, where S is the shock strength. This is contrary to results for sink flow which have been obtained by the use of Lighthill's technique for rendering approximations uniformly valid (Abstr. 2120/1950). It is shown that this method fails when applied to singular perturbation problems of the type discussed here, in which the small parameter multiplies the highest derivative

534.222.2 : 537.56

STRUCTURE OF SHOCK FRONTS IN IONIZED GASES.
See Abstr. 5828.

534.2

6640. COMPRESSIONAL RELAXATION IN LIQUIDS. R.E.Nettleton.

J. Acoust. Soc. Amer., Vol. 31, No. 5, 557-67 (May, 1959).

A set of phenomenological equations, valid at all frequencies, i proposed for the rates of change of internal relaxation parameters describing molecular excitations and structural changes in a liquid.

An Onsager coupling is found to exist between the rate equations for the parameters and the pressure tensor, so that the diagonal terms of the pressure contain a linear sum of thermodynamic affinities governing the internal irreversible processes. These affinities can be eliminated from the pressure, using the rate equations, to give a complex compressional modulus, reducing to a bulk viscosity term at low frequencies and a contribution to the bulk modulus at very high frequencies. The bulk viscosity is calculated at 20°C for two nonassociated liquids, on the assumption of a single thermal and single structural relaxation time, with use of a "hole" model of structural relaxation based on a shear viscosity theory of Mooney. The acoustic absorption coefficient is computed from the bulk viscosity, yielding fair order-of-magnitude agreement with experiment in both cases.

534.23

6641. THREE-DIMENSIONAL INVESTIGATION OF THE PROPAGATION OF WAVES IN HOLLOW CIRCULAR CYLINDERS.
I. ANALYTICAL FOUNDATION. D.C.Gazis.

J. Acoust. Soc. Amer., Vol. 31, No. 5, 568-73 (May, 1959).

The propagation of free harmonic waves along a hollow circular cylinder of infinite extent is discussed within the framework of the linear theory of elasticity. A characteristic equation appropriate to the circular hollow cylinder is obtained by use of the Helmholtz potentials for arbitrary values of the physical parameters involved. Axially symmetric waves, the limiting modes of infinite wavelength, and a special family of equivoluminal modes are derived and discussed as degenerate cases of the general equations.

534.23

6642. THREE-DIMENSIONAL INVESTIGATION OF THE PROPAGATION OF WAVES IN HOLLOW CIRCULAR CYLINDERS.
II. NUMERICAL RESULTS. D.C.Gazis.

J. Acoust. Soc. Amer., Vol. 51, No. 5, 573-8 (May, 1959).

The results are given of a numerical evaluation of a characteristic equation derived in Pt I (preceding abstract), appropriate to free harmonic waves propagated along a hollow cylinder of infinite extent. This equation is evaluated for some representative cylinders covering the entire range from thin shells to solid cylinders, and the results are compared with the corresponding results of a shell theory. Observations are made regarding the variation of the frequency spectrum with the physical parameters, as well as the range of applicability of shell theories.

534.23 : 541.135

6643. PHENOMENOLOGICAL THEORY OF ULTRASONIC VIBRATION POTENTIALS IN LIQUIDS AND ELECTROLYTES.

A.Weinmann.

Proc. Phys. Soc., Vol. 73, Pt 3, 345-53 (March, 1959).

A macroscopic phenomenological relationship is proposed, which takes into account the electric polarization produced in a liquid when density gradients are present. This is used to calculate the ultrasonic vibration potentials in an electrolyte, thus generalizing the Debye formula for this effect, to the case where the pure solvent produces its own potentials. The formula is in agreement with the few available experimental observations for reasonable values of the parameters. A calculation is also made of the disturbing effect of the measuring electrodes, and a simple equivalent circuit is derived under certain reasonably general conditions, from which the effect of an arbitrary impedance of the measuring apparatus can be allowed for.

534.23 : 551.596

INFLUENCE OF TURBULENCE ON THE ATTENUATION OF SOUND IN FREE AIR. See Abstr. 6405

534.23

6644. ACOUSTIC PROPERTIES OF HEMOGLOBIN SOLUTIONS.

E.L.Carstensen and H.P.Schwan.

J. Acoust. Soc. Amer., Vol. 31, No. 3, 305-11 (March, 1959).

Absorption and velocity of sound in the range 0.5 to 10 Mc/s were measured for solutions of haemoglobin under various conditions of temperature, concentration, and chemical environment. The haemoglobins of several species of mammals and different chemical forms of haemoglobin were studied. In the absorption per wavelength only minor variations with frequency were observed. Dispersion in the velocity of sound of these solutions was measured. It was possible to relate quantitatively the magnitude of the absorption and dispersion through relaxation theory by assuming a broad distribution of relaxation times.

534.23

6645. MEASUREMENT OF ULTRASONIC ABSORPTION IN LIQUIDS BY THE OBSERVATIONS OF ACOUSTIC STREAMING.

D.N.Hall and J.Lamb.

Proc. Phys. Soc., Vol. 73, Pt 3, 354-64 (March, 1959).

Propagation of an ultrasonic wave through an absorbing liquid contained in a tube gives rise to a gradient of pressure along the axis which is determined by observing the velocity of flow of the liquid through a side tube connected in parallel with the main tube. The intensity of the ultrasonic wave is found by recording the voltage applied to the exciting transducer, the parameters of which are measured in the vicinity of resonance. Obstruction of the sound field by the intensity measurement is thus avoided. The observations are used to evaluate the absorption coefficients of liquids over the range 130 kc/s to 1560 kc/s. The limits and accuracy of the technique are discussed and a new theoretical approach enables the pressure gradient to be derived from second-order acoustic variables without recourse to the concept of radiation pressure.

534.232

6646. STRAIN GAUGE MEASUREMENT OF OUTPUT OF MAGNETOSTRICTIVE ULTRASONIC TRANSDUCER — PITFALLS OF OPTICAL MEASUREMENT. H.Lamport and H.H.Zinsser.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 435-8 (April, 1959).

An easily fabricated, bifilar wire strain gauge wound helically about the hilt of an ultrasonic magnetostrictive transducer measures amplitude faithfully and is more convenient than optical methods. Pitfalls in the usual optical method are illustrated and discussed.

534.232

6647. ANALYSIS OF A PIEZOELECTRIC PHONOGRAPH TRANSDUCER AS A FUNCTION OF THE CLAMPING POSITION.

D.H.Howling.

J. Acoust. Soc. Amer., Vol. 31, No. 5, 620-7 (May, 1959).

A laterally vibrating piezoelectric phonograph transducer is analysed by treating the transducer as a transmission line. The effect of clamping the crystal at any point is simulated by introducing into the line at the corresponding point a capacitance whose value is related to the compliance of the clamp. The record load appears as a terminating impedance at the end of the line. Several response curves corresponding to different loading and clamping positions were determined from the electrical analogy for both playback and record.

534.242

6648. ACOUSTICAL RESONANCES PRODUCED BY COMBUSTION OF A FUEL—AIR MIXTURE IN A RECTANGULAR DUCT. I.Elias.

J. Acoust. Soc. Amer., Vol. 31, No. 3, 296-304 (March, 1959).

An experimental programme was conducted with a $2\frac{1}{2} \times 10$ in. model ramjet combustor directed towards understanding the mechanisms which maintain high-frequency combustion pressure oscillations (commonly referred to as "screech") in the air-breathing jet engine. Results show that pressure oscillations characteristic of transverse acoustic modes occur as fuel—air mixtures approach stoichiometric values. The particular mode excited is related to orientation of the flame fronts in the duct, which in turn are functions of the particular flame holder geometry. It is shown that heat release associated with the flame fronts occurs in high-impedance zones for the modes excited. High-speed motion pictures of the combustion zone during screech show that the flame fronts are serrated, the number of serrations being proportional to screech frequency. The serrations are interpreted to be related to vortex shedding from the flame holder lips. High-amplitude oscillations corresponding to the fundamental longitudinal mode occurred when conditions of intense screech were achieved. This mode transference is attributed to increased heat addition in the forward portion of the duct, a position favourable for driving longitudinal modes. Preliminary results show that high-turbulence levels produce screech at lower values of fuel—air mixture.

534.3

6649. PROPOSED KEYBOARD MUSICAL INSTRUMENT.

M.Clark, Jr.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 403-19 (April, 1959).

A musical instrument is proposed with the following elements: a tone generator capable of reproducing the attack and decay transients and the steady-state of the tones of conventional musical instruments with correctly proportional partials, the frequencies of those associated with one note being integral multiples of a low frequency; keyboards sensitive to the speed with which a key is depressed and the distance to which it is depressed, so that the intensity of each note may be expressively controlled at all times; a unit for the controllable generation of massive choruses from solo voices by producing narrow, complex spectra about each partial; an intensity control unit; environment modification equipment to alter the apparent size of the room within which the music is heard and the apparent size and location of the source, and to distribute and diffuse the sound; a preset unit in which sequences of timbre, vibrato, choral massiveness, environmental characteristics, and other factors may be established before performance and quickly and easily called forth during performance. The features include tones of familiar character and quality, realistic choral effects, expressive touch, environmental control, flexibility, and ease of playing. Numerical results are appended to demonstrate the feasibility of construction.

534.321.9 : 535.42

THE EFFECT OF A PROGRESSIVE ULTRASONIC WAVE ON A LIGHT BEAM OF FINITE WIDTH. See Abstr. 5593

534.37

6650. ACOUSTICAL DAMPING FOR LINEAR ACCELEROMETERS.
C.K.Stedman.

J. Acoust. Soc. Amer., Vol. 31, No. 3, 333-7 (March, 1959).

The system described uses a diaphragm, a coupling chamber, and a resistive element in the form of a plug of porous sintered metal. A major feature of the development is the use of pressurization to match the acoustic impedance of the coupling chamber to that of the plug. Critical requirements which must be satisfied by the diaphragm, the chamber, the plug, and its acoustical termination are presented. The theoretical frequency response is presented in dimensionless form, and expressions for the dimensionless parameters are given in terms of physical constants of the instrument. Experience with instruments designed according to these principles and manufactured in quantity has confirmed the theory.

534.422

6651. SIREN DESIGN FOR PRODUCING CONTROLLED WAVE FORM WITH AMPLITUDE MODULATION.
C.H.Allen and B.G.Watters.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 463-9 (April, 1959).

A siren was developed which permits the generation of a sound pressure wave with harmonics more than 15 dB below the fundamental over a broad frequency range and over a range of power output exceeding 40 dB. The large dynamic range was obtained by the use of a shutter which changes the maximum open area of the siren ports and simultaneously alters the time variation of area so that the output signal remains substantially sinusoidal at any shutter position. The shutter can be operated rapidly to provide a means for programmed amplitude modulation of the output signal with a minimum of harmonic distortion.

534.44

6652. METHOD OF OBTAINING AMPLITUDE AND PHASE SPECTRA OF A TRANSIENT FUNCTION USING GRAPHICAL INPUT DATA.
W.J.Remillard.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 531-4 (April, 1959).

Both amplitude and phase spectra are needed to characterize transient functions completely. Analysis shows how these spectra can be obtained from the envelopes of the line spectra of the even and odd parts of a transient function made to recur in time. Instrumentation is described for the convenient determination of these line spectra.

534.6 : 621.317.39

6653. ACOUSTIC MEASUREMENT METHODS AND MEASURING APPARATUS.
J.J.Geluk.

Tijdschr. Ned. Radiogenoot., Vol. 23, No. 6, 247-71 (Nov., 1958). In Dutch.

A survey of historical acoustic measuring apparatus is given, in particular, that giving quantitative results. Modern methods are described for measuring acoustic pressure — the pistonphone for h.f. and those based on the reciprocity principle for higher frequencies —, velocity of sound, intensity (determined from velocity and pressure in a given direction), sound pressure (energy density), and acoustic impedance. A further section discusses subjective qualities such as pitch, loudness, and architectural acoustics with consideration of insulation. An account is given of the acoustic test house of Hilversum Radio and of methods for determining the effectiveness of sound diffusing walls. G.N.J.Beck

534.61

6654. NOISE-REDUCING LINE MICROPHONE FOR FREQUENCIES BELOW 1 cps.
F.B.Daniels.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 529-31 (April, 1959).

A novel type of line microphone is described that utilizes a distributed input primarily for the purpose of improving signal-to-wind-noise ratio. The input to the transducer takes place through a tapered pipe that is coupled to the atmosphere by means of acoustical resistances uniformly spaced along the length of the pipe. The relationship between the resistances of the openings and the longitudinal variations in the characteristic impedance of the pipe is so adjusted as to make the system nonreflecting. Microphones of this type have been constructed for use in the frequency range below 1 c/s for the purpose of studying atmospheric pressure oscillations in this range. A prototype, 1980 ft long with 100 openings, which gives an improvement in the signal-to-noise ratio of as much as 20 dB under severe wind conditions, is described.

534.612

6655. ANALYSIS OF A LOGARITHMIC SOLION ACOUSTIC PRESSURE DETECTOR.
A.F.Wittenborn.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 475-8 (April, 1959).

An analysis is given of a solion acoustic pressure detector which has a direct current output proportional to the logarithm of the pressure input. An approximate method is used which avoids solving the Navier—Stokes equation describing the fluid flow and the convection diffusion equation for calculating the current. The calculation consists of (1) solving the zero flow "transient" diffusion equation for the reducible component in the electrochemical redox system, (2) using this transient solution to calculate the output current, with the time spent inside the detector orifice as the independent variable, and (3) relating this time to the pressure by using the known acoustic impedance of the detector orifice. The calculated results show that the logarithmic response is obtained through a combination of diffusion and hydrodynamic effects. For the ideal case of constant impedance as a function of volume flow, the logarithmic response is degraded.

534.7

PHYSIOLOGICAL ACOUSTICS. HEARING. See also the Section entitled "BIOPHYSICS. PHYSIOLOGICAL PHYSICS".

534.78

6656. INTELLIGIBILITY OF REITERATED SPEECH.
D.J.Sharf.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 423-7 (April, 1959).

An attempt is made to increase the intelligibility of speech sampled in time (interrupted speech) by filling in the blank spaces with repetitions of the speech samples (reiterated speech). The experiment involves the evaluation of these processes of speech distortion in quiet and in noise with two duty cycles (speech-time fractions), with various rates of interruption of the speech signal, and with various buildup and decay times in the switching operation. The results indicate that (1) there is little difference between the intelligibility of reiterated speech and interrupted speech in quiet; (2) reiterated speech is more intelligible than interrupted speech in noise if signal measurements are based on instantaneous amplitudes of the speech samples, and (3) buildup and decay has little effect on the intelligibility of interrupted speech when the entire buildup phase is confined to the "on" time of the switching period.

534.78

6657. VOWEL AMPLITUDE AND PHONEMIC STRESS IN AMERICAN ENGLISH.
I.Lehiste and G.E.Peterson.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 428-35 (April, 1959).

Many different instrumental techniques for deriving an energy property of the speech wave have been employed in communication studies. There is as yet, however, no satisfactory method of calculating the loudness of the various types of complex quasi-periodic sounds that appear as time functions in speech. This paper does not present a method of making such loudness calculations, but suggests that any such method would be inadequate for deriving physical correlates of accent or stress judgments about speech. The study reports volume indicator and instantaneous amplitude observations on sustained vowels produced under various conditions of speech effort and on vowels produced in CNC syllables in a carrier phrase with stress held constant. The untested theory is proposed that the perception of linguistic stress is based upon judgments of the physiological effort involved in producing vowels. The relative amplitude and spectrum of the vowel provide the chief basis for judgment of the physiological effort.

534.781

6658. INTELLIGIBILITY OF KNOWN AND UNKNOWN MESSAGE SETS. I.Pollack, H.Rubenstein and L.Decker.

J. Acoust. Soc. Amer., Vol. 31, No. 3, 273-9 (March, 1959).

The effect of the frequency of occurrence of words upon their intelligibility in noise was examined under two conditions: (1) in unknown message sets where the specific words under test were initially unknown to the listener; and (2) in known message sets where the specific words under test were known to the listener. Substantial effects of word frequency are observed with unknown message sets, but not with known message sets. In known message sets, the prime factor determining intelligibility is the phonemic interconfusability among the words. In unknown message sets, it is suggested that the important determinant of the intelligibility of a word is its frequency of occurrence relative to the frequencies of the words with which it might be confused.

534.784

6659. LINGUISTIC CONSIDERATIONS IN THE STUDY OF SPEECH INTELLIGIBILITY. I.Lehiste and G.E.Peterson.

J. Acoust. Soc. Amer., Vol. 31, No. 3, 280-6 (March, 1959).

Intelligibility is defined as a property of speech communication involving meaning. Since only meaningful units have normal linguistic distributional properties, only meaningful units have the phonetic properties of actual speech. An auditory intelligibility dialect ratio is defined for a listener relative to a specified message. An analysis is presented of the Harvard PB lists, and a set of 10 lists of 50 monosyllables each is presented having an almost exact first-order phonemic balancing.

534.79

6660. CRITICAL BANDS AND THE LOUDNESS OF COMPLEX SOUNDS NEAR THRESHOLD. B.Scharf.

J. Acoust. Soc. Amer., Vol. 31, No. 3, 365-70 (March, 1959).

The loudness of multitone complexes and bands of white noise was measured as a function of bandwidth at levels between 5 and 35 dB above threshold. When account is taken of the changes in the loudness that are due to the nonuniformity of the ear's sensitivity at low levels, the spreading of energy appears to have the same general effect on the loudness of both line spectra and continuous spectra centred at frequencies as low as 400 c/s and as high as 5000 c/s. At 5 dB S.L. the spreading of energy does not increase the loudness, and may even decrease it. Above about 10 dB S.L. the spreading of energy in a complex sound over more than a critical band increases the loudness. As the sensation level is raised up to 35 dB the spreading of energy becomes more and more advantageous to loudness. The critical band defines the limits within which the spreading of energy leaves the loudness of a complex sound unchanged. The widths of the critical bands that were measured in these experiments on loudness summation below 35 dB are approximately the same as those measured in experiments on loudness summation at higher levels and also in experiments on phase, threshold, and two-tone masking.

534.79

6661. ON THE LAMBDA LOUDNESS FUNCTION, MASKING, AND THE LOUDNESS OF MULTICOMPONENT TONES. W.R.Garner.

J. Acoust. Soc. Amer., Vol. 31, No. 5, 602-7 (May, 1959).

A computational procedure is presented for determining the loudness of multicomponent tones. The procedure uses the lambda loudness function and has just two basic assumptions: (1) loudness of components add as the sum of their squares, and (2) the effect of masking is to subtract a constant amount of loudness. With these two assumptions, the loudness data of Fletcher and Munson for multicomponent tones are predicted, using the lambda function and the masking data of Wegel and Lane for the necessary predictive terms. This procedure gives better accuracy than the original calculational schema of Fletcher and Munson, even though no constants are determined from the data. In fact the three sets of data (loudness scaling, masking, and multicomponent loudness) can be used such that any two will correctly predict the third. It seems possible that the lambda function may provide better integration of auditory data than other loudness functions.

534.839

6662. ON THE DETECTION OF SIGNALS IN NONSTATIONARY NOISE BY PRODUCT ARRAYS. J.B.Thomas and T.R.Williams.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 453-62 (April, 1959).

Two detection systems having multiple inputs each consisting of nonstationary noise and a stationary random signal are analysed and compared on a signal-to-noise ratio basis. In both systems the inputs are divided into two groups and the sum of each group is formed. In the first system the resulting two wave forms are multiplied directly and the product averaged. In the second system the two wave forms are strongly clipped prior to multiplication, forming a polarity-coincidence correlator. Previous studies have shown the latter system to be slightly inferior for stationary noise. The results of this paper show that the latter system may be quite superior in certain types of nonstationary noise.

534.832

6663. SHIELDING FLAP TYPE JET ENGINE NOISE SUPPRESSOR. D.J.Maglieri.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 420-2 (April, 1959).

Far-field noise measurements from model tests of a shielding flap type jet noise suppressor are presented in the form of radiation patterns and frequency spectra. The tests were conducted using a cold air jet issuing from the nozzle in such a manner as to attach to and flow along the surface of a shielding flap. Whereas other proposed noise suppressors provide generally symmetrical noise radiation patterns, the present device skews the pattern in a beneficial way such that large noise reductions are obtained in the downward direction. These large noise reductions are thought to result from both the acoustic shielding of the flap and the benefits of flow attachment.

534.84

6664. ACOUSTICAL FACTORS IN JET AIRPORT DESIGN. K.Eldred.

J. Acoust. Soc. Amer., Vol. 31, No. 5, 547-57 (May, 1959).

With the advent of commercial jet airline operations, increased importance must be placed upon acoustical considerations in airport design. This paper reviews the relationships between the noise resulting from commercial jet and propeller airliner operations, including takeoff, taxi, and idle, for various projected traffic densities and various airport building functional design criteria. Presently used criteria are explained and new criteria are suggested to fill a gap in the over-all evaluation procedure for short time noises. Methods and examples are presented which expedite initial visualization of the major acoustical factors in an airport design situation, facilitate decisions for preliminary airport building layout, and enable evaluation of possible wall and roof structures.

534.843

6665. ON THE ACOUSTICS OF COCKTAIL PARTIES. W.R.MacLean.

J. Acoust. Soc. Amer., Vol. 31, No. 1, 79-80 (Jan., 1959).

Parties are classified as loud or quiet, and the distinction is shown to depend often upon a critical acoustic relationship rather than upon the guests themselves. An explicit formula is found for the maximum number N of well-mannered guests compatible with the quiet party. When this number is exceeded, the party will become a loud one within a calculable time T.

534.843

6666. COCKTAIL PARTY ACOUSTICS. H.C.Hardy.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 535 (April, 1959).

See preceding abstract.

534.845

6667. ABSORPTION OF SOUND BY A STRIP OF ABSORPTIVE MATERIAL IN A DIFFUSE SOUND FIELD.

T.D.Northwood, M.T.Grisaru and M.A.Medcof.

J. Acoust. Soc. Amer., Vol. 31, No. 5, 595-9 (May, 1959).

The random incidence sound absorption coefficient is calculated for a narrow strip of absorbing material set in an otherwise reflecting plane. The assumptions made are that the material is of the locally reacting type, with a real normal admittance. The effect of an imaginary component of admittance is discussed qualitatively. The results show the increase in absorption coefficient that occurs at small widths due to diffraction. Consideration is also given to the absorption of rectangular patches having both dimensions in the diffraction range. The standard reverberation room measurement of sound absorption is examined.

534.88 : 519.21

6668. CORRELATION OF A FINITE DISTANCE POINT SOURCE. M.J.Jacobson.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 448-53 (April, 1959).

A two-receiver steerable correlation system intended to process signals from point sources at a large distance from and in a common plane with the receivers will give a predicted source direction which is generally different from the actual source direction when the source distance from the receivers is not large. The exceptions are broadside or end-fire sources for which the predicted and actual directions are equal. Apart from these cases, the predicted direction is always closer to broadside than the actual direction. Other results include the fact that a given predicted direction corresponds to a source location at any point on a corresponding hyperbolic arc.

OPTICS . SPECTRA . LUMINESCENCE

535.1 : 530.11

THEORY OF LIGHT EMISSION. See Abstr. 6484

535.14 : 535.411

6669. ON PHOTON COINCIDENCES AND HANBURY BROWN'S INTERFEROMETER. F.D.Kahn.
Optica Acta, Vol. 5, No. 3-4, 93-100 (Sept.-Dec., 1958).

Some statistical results are established which govern the rate of detection of photons reaching a small receiver and coming from a source which is too small for the receiver to resolve. The results are used to find the probability of the coincident arrival of a pair of photons at two small receivers trained on the same source. In essence, Hambury Brown's interferometer is a device which measures this probability. The statistical results are used to estimate what signal-to-noise ratio may be expected when the interferomer is used.

535.222.2

6670. REFLECTION AND REFRACTION OF SHOCK WAVES AT THE INTERFACE BETWEEN TWO MEDIA. I. CASE OF NORMAL INCIDENCE. A.I.Gubanov.
Zh. tekh. Fiz., Vol. 28, No. 9, 2035-40 (Sept., 1958). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 3, No. 9, 1869-74 (Sept., 1958).

A general equation is obtained from which one can find the pressure in the reflected shock wave when a plane shock wave is normally incident on a plane interface between two arbitrary media. This equation is solved approximately for the case of two ideal gases, for shock waves of small intensity, for media which are only slightly different, and for media that are decidedly different.

535.23 : 536.3

6671. SPECTRAL EMISSIVITY OF TUNGSTEN. R.D.Larrabee.
J. Opt. Soc. Amer., Vol. 49, No. 6, 619-25 (June, 1959).

An experiment designed to measure the spectral emissivity of tungsten, in which a direct comparison method is utilized so that the spectral emissivity is observed directly as the ratio of light intensity from a tungsten source to that from a blackbody source, is described. The spectral emissivity was measured over the wavelength interval 310 to 800 mμ, and the temperature interval 1600° to 1400°K.

535.23.08 : 536.33.08

6672. POSSIBILITIES AND LIMITATIONS OF INFRARED IMAGE CONVERTORS. T.Schneider and P.Schranz.
Z. angew. Math. Phys., Vol. 9a, No. 3, 251-60 (Sept. 15, 1958). In German.

The dependence of infrared image convertors on cathode sensitivity and temperature, dark current and various parameters of the optical system is discussed. Conditions for an element in the object to be just visible are obtained. W.T.Welford

535.23.08 : 539.2

SOLID STATE INFRARED QUANTUM COUNTERS. See Abstr. 6281

535.231 : 537.523.5

RADIATION LOSSES FROM ARC COLUMN. See Abstr. 5760

535.232

6673. SECONDARY STANDARD OF SPECTRAL DISTRIBUTION IN THE VISIBLE SPECTRUM. K.Yoshié and N.Ooba.
Rev. Opt., Vol. 36, No. 12, 561-9 (Dec., 1957). In French.

The spectral distribution of the light from a tungsten ribbon lamp is not identical with that from a total radiator (black body) at the same colour temperature. At 2050°K the difference may be as much as 3% near the ends of the spectrum. The authors have determined the spectral distribution for a number of selected standard lamps. They suggest that the spectral distribution of such a lamp should be expressed by means of the colour temperature for a limited region of the spectrum rather than for the whole of the visible. J.W.T.Walsh

535.242.62

6674. SYSTEMATIC ERROR INHERENT IN THE FLICKER METHOD OF HETEROCHROMATIC PHOTOMETRY. Y.Galifret and H.Piéron.
Rev. Opt., Vol. 36, No. 4, 157-70 (April, 1957). In French.

Three monochromatic radiations of wavelengths 670, 535 and 475 mμ respectively were compared with a yellow (585 mμ) by three methods. The step-by-step and direct comparison methods gave results in fair agreement, but in relation to these the results given by the flicker method were too low (by a factor of about 2.5) for the red and the green but not for the blue. The luminance was 1 cd/m^2. This under-estimation is attributed to the use of colour perception instead of brightness perception when estimating the state of balance in the flicker photometer. J.W.T.Walsh

535.247.4

6675. A COMPENSATED PHOTOELECTRIC MICROPHOTOMETER. V.Nadol'skiĭ and A.Itsikovich.
An. Stiint Univ. "Al. I. Cuza" Iasi I (Ser. noua), Vol. 3, No. 1-2, 225-31 (1957). In Russian.

A null-type microphotometer, using two selenium cells as sensitive elements, is described. It is compensated for variations in the emission of the light sources used and for "fatigue effects" in the selenium cells (decrease of sensitivity on prolonged irradiation). The instrument is meant for photometry of photographic records of star images, spectra etc. A.Tybulewicz

535.247.4 : 621.317.39

6676. AUTOMATED UNIVERSAL DISTRIBUTION PHOTOMETER. J.S.Franklin.
Illum. Engng, Vol. 53, No. 12, 667-78 (Dec., 1958).

After listing 24 basic requirements for an automatic photometer to be used to determine the light distribution from a fitting such as a street lighting fitting, a practical instrument is described with which complete information as to distribution can be obtained in about one-third of the time taken when an ordinary hand-operated photometer is used. J.W.T.Walsh

535.25

6677. DETERMINATION OF THE INTENSITY DISTRIBUTION RESULTING FROM THE RANDOM ILLUMINATION OF A PLANE FINITE SURFACE. M.J.Beran.
Optica Acta, Vol. 5, No. 3-4, 88-92 (Sept.-Dec., 1958).

The intensity is found by solving the equations governing the propagation of the two point correlation function in free space. Using an ensemble average, the distribution at some distance from the radiating surface is found to be the Lambertian distribution multiplie by the Fourier transform of the correlation function defined over the illuminated surface. The ensemble average is then shown to be equivalent to either space or time averages in a variety of cases.

535.3 : 539.234

OPTICAL PROPERTIES OF VARIOUS EVAPORATED RARE EARTH OXIDES AND FLUORIDES. See Abstr. 6308

535.31

6678. EQUIVALENCE OF HUYGENS' PRINCIPLE AND FERMAT'S PRINCIPLE IN RAY GEOMETRY. A.J.de Witte.
Amer. J. Phys., Vol. 27, No. 5, 293-301 (May, 1959).

Rays determined by Huygens' construction are identical with those derived from Fermat's principle. This is shown to be true whatever the medium or sequence of media traversed by the rays.

535.317

6679. PRINCIPLE OF AN APPARATUS FOR MEASURING THE TRANSMISSION FACTORS FOR SPATIAL FREQUENCIES OF PHOTOGRAPHIC OBJECTIVES. P.Lacomme.
Acta Electronica, Vol. 2, No. 1-2, 263-5 (1957-58). In French.

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). The apparatus uses as test object a glass drum with a constant pitch square-wave pattern on its periphery. This is imaged through a variable power system (range 1 : 9) and either of two collimators, giving a total range of 1 : 20 in spatial frequency. The image is received by a photomultiplier; electric filter circuits ensure that only the fundamental of the square-wave pattern is measured. W.T.Welford

535.317

6680. IMPROVEMENT OF THE CONTRAST OF PHOTOGRAPHIC IMAGE DETAIL BY FILTERING SPATIAL FREQUENCIES.
A.Maréchal, P.Croce and K.Dietzel.
Acta Electronica, Vol. 2, No. 1-2, 256-62 (1957-58). In French.

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). Photographs were illuminated coherently and apodising filters were placed at the image of the source. Examples are shown of the improvement obtained and the method of making the filters is described. W.T.Welford

535.317

6681. IMPROVEMENT OF THE CONTRAST TRANSFER FUNCTION. A.Lohmann.
Acta Electronica, Vol. 2, No. 1-2, 293-8 (1957-58). In German.

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). Qualitative study of the possibilities of apodisation for improving the response function. 27 references. W.T.Welford

535.317

6682. ON THE CONTRAST TRANSFER THEORY OF OPTICAL IMAGERY IN INCOHERENT ILLUMINATION FROM THE STANDPOINT OF GEOMETRICAL OPTICS. W.Lukosz.
Acta Electronica, Vol. 2, No. 1-2, 299-306 (1957-58). In German.

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). The response function can be evaluated according to geometrical optics as the radius of gyration of the spot diagram (Gauss' criterion of image quality) and the results agree well with the diffraction-theoretic values at low frequencies. Aberration balancing for smallest radius of gyration by means of circle polynomials is discussed. 30 references. W.T.Welford

535.317 : 522.6

6683. APPROXIMATE CORRECTION TO THE LOBE EFFECT IN RADIOASTRONOMY. J.Arsac.
Optica Acta, Vol. 6, No. 2, 103-16 (April, 1959). In French.

A simple method of numerical calculation is described which can be used to correct the form of the transmission curve of the spatial frequencies in an optical instrument. The method is compared with previous ones. Applications are given to problems in radioastronomy for different types of instrument.

535.317.1

6684. IMAGE QUALITY AND OPTICAL RESOLUTION.
E.H.Linfoot.
Optica Acta, Vol. 4, No. 1, 12-16 (March, 1957).

A brief account is given of the reasons why the classical notion of resolving power fails to provide a satisfactory quality criterion of optical systems designed to form images of extended objects. The discussion indicates that a quantity here called the "structural resolving power", which is formally identical with an assessment proposed independently by Schade (1952) and Fellgett (1953), seems well suited to replace the old notion of resolution limit in evaluating the images of extended objects. On the basis of known results about images by systems with annular apertures, and of the rather close relation between the structural resolving power of an optical system and its information-passing capacity, it is concluded that the image of an extended object showing low-contrast fine structure begins to show visible deterioration when the reduction in the structural resolving power of the optical system by aberrations or by central obstruction reaches about 20%.

535.317.1 : 530.162

SPECTRAL ANALYSIS OF A FUNCTION. REDUNDANCY PROBLEM. See Abstr. 6556

535.317.2

6685. FACTORS AFFECTING THE ACCURACY OF DISTORTION MEASUREMENTS MADE ON THE NODAL SLIDE OPTICAL BENCH.
F.E.Washer and W.R.Darling.
J. Opt. Soc. Amer., Vol. 49, No. 6, 517-34 (June, 1959).

In evaluating distortion with the visual nodal slide optical bench, the transverse displacements to right and left of centre upon which the values of distortion are based are likely to be asymmetric with respect to the initial setting made at the axial focus. Several factors that contribute to this condition are (1) transverse displacement of the rear nodal point of the lens with respect to the centre of rotation of the nodal slide, (2) misalignment of the collimator, and (3) prism effect on the lens. The manner in which these factors affect the observations is discussed. It is shown that the accuracy of the values of distortion are not adversely affected provided proper care is taken. A test for consistency of observations is developed and demonstrated. Results of measurements on several lenses are given that demonstrate the effect of the various factors.

535.317.3

6686. SELECTION OF GLASSES FOR THREE-COLOR ACHROMATS. R.E.Stephens.
J. Opt. Soc. Amer., Vol. 49, No. 4, 398-401 (April, 1959).

If two thin lens elements of two different glasses are combined into a thin two-element system, then the chromatic properties of the system may be described by the effective values of $V[V = (N - 1)/(N_F - N_C)]$, and $P[P = (\Delta N/N_F - N_C)]$. The effective value $\overline{P}$ is a linear function of $\overline{V}$. On a graph of P v. V, the straight line drawn through the points for two glasses is the locus of all possible effective values of V and P for combinations of these two glasses. By means of such a graph the effective value P for a combination of two glasses may be matched to $\overline{P}$ of a third glass whose V differs from $\overline{V}$ by a useful amount. An achromatic lens system of the three glasses may then be computed, which will have a common focal length for three wavelengths.

535.317.3

6687. THE CHROMATIC DISPERSION OF A FRESNEL LENS.
P.Blaise.
Rev. Opt., Vol. 36, No. 8-9, 423-9 (Aug.-Sept., 1957). In French.

The intensity distribution and colour variation are calculated in the beam produced by a Fresnel lens used in a lighthouse. It is shown that there is a slight spreading of the beam and that the intensity at the edge is about a quarter of the central intensity. The colour of the beam as a function of the distance from the centre is also calculated. R.W.Fish

535.317.5

6688. FURTHER CONSIDERATIONS OF THE CONCENTRIC SYSTEM FORMED BY TWO SPHERES HAVING INDICES n_1 AND n_2.
C.Morais.
Atti Fond. Ronchi, Vol. 14, No. 2, 147-57 (March-April, 1959).
In Italian.

For previous work, see Abstr. 1251/1959. An optical system is considered which consists of a spherical core (having index n_2 and radius $R_2 = 1/n_2$) enclosed by a spherical shell (having index n_1 and radius $R_1 = 1$). The spherical aberration is worked out for values of H very close to 1. The zonal aberration is also worked out for two different values of H, taking $S'_4 = 1$, where S'_4 is the distance of the image from the centre of the system.

535.317.5

6689. CONCENTRIC SYSTEMS WITH TWO [DIFFERENT] GLASSES. M.T.Zoli.
Atti Fond Ronchi, Vol. 14, No. 2, 159-63 (March-April, 1959).
In Italian.

The behaviour of the spherical aberration for a class of optical systems with spherical symmetry is considered. Such systems consist of an outer shell and inner core of different (but constant) refractive index. The expansions of spherical aberration in power series of the height and of the angle of incidence, respectively, show that the spherical aberration of such systems assumes negative values and does not depend on the refractive index close to k = 1. The correction of the spherical aberration is obtained for a restricted region.

535.317.5

6690. DIFFERENTIAL METHOD FOR ADJUSTING THE WAVE-FRONT ABERRATIONS OF A LENS SYSTEM. T.Suzuki and I.Uwoki.
J. Opt. Soc. Amer., Vol. 49, No. 4, 402-4 (April, 1959).

The resultant increment of the wave-front aberration of a lens system which is produced by a small change of the constructional parameter in the system can be represented by the equation

$$\partial w/\partial x_i \, \Delta x_i = \partial w_1/\partial x_i \, \Delta x_i - N'_K(1 - \cos u'_K)\partial \bar{s}'_K/\partial x_i \, \Delta x_i,$$

where w and Δx_i denote the wave-front aberration and the increment of the constructional parameter, respectively. The first term of the right-hand side of the equation represents the increment of the wave-front aberration with respect to the original reference sphere and the second term shows the increment produced by the focal shift due to the change of the constructional parameter. The numerical result obtained from the equation showed fairly good agreement with that obtained by the actual ray tracing.

535.317.5

6691. APPLICATION OF DIFFRACTION THEORY TO THE CORRECTION OF SPHERICAL ABERRATION. G.Grosset.
Rev. Opt., Vol. 36, No. 6, 272-80 (June, 1957). In French.

Considering only primary and secondary spherical aberration it is postulated that the plane of best focus (maximum Strehl definition) is that for which the maximum and minimum in the wavefront aberration Δ are equal in absolute magnitude. For this focus Δ can be written as a function of the aperture involving two parameters, Δ_{max} and the maximum aperture. Curves are given for the Strehl definition as a function of these parameters. W.T.Welford

535.317.5

6692. EFFECT OF THE CONDENSER'S ABERRATION ON THE IMAGE FORMED IN A MICROSCOPE. J.Tsujiuchi.

Rev. Opt., Vol. 38, No. 2, 57-74 (Feb., 1959). In French.

Studied using the concept of the "effective source" defined by Hopkins (Abstr. 4688/1953). It is shown that the effect appears when the condenser's aberration is large and the light source small. The tolerance of the condenser's aberration is calculated.

535.317.6

6693. LENS DESIGNING BY ELECTRONIC DIGITAL COMPUTER. I. C.G.Wynne.

Proc. Phys. Soc., Vol. 73, Pt 5, 777-87 (May, 1959).

The problem of automatic lens designing by an electronic digital computer is considered in the light of existing aberration theory. Methods previously suggested are discussed, and a new iterative method of linear approximation is described.

535.317.7

6694. A METHOD OF MEASURING THE CONTRAST TRANSMISSION FUNCTION OF PHOTOGRAPHIC OBJECTIVES. K.Rosenhauer and K.J.Rosenbruch.

Optica Acta, Vol. 4, No. 1, 21-30 (March, 1957). In German.

The contrast K of a self-luminous or incoherently illuminated object is defined by $K = (J_{max} - J_{min})/(J_{max} + J_{min})$ where J is the intensity of illumination. When an optical system forms an image of the object, the contrast is reduced, due to diffraction, aberrations, and veiling-glare. The reduction of contrast is a function of the size of the object (or of the spatial frequency), the relative aperture of the imaging system and its state of correction. An apparatus is described for measuring this contrast transmission function for miniature camera-lenses. The objective to be tested projects on to a narrow slit the image of a rotating grating having varying frequencies, and $K = 1$. A photomultiplier gives an output proportional to the intensity of transmitted light and a cathode ray oscillograph, synchronized with the rotation of the grating, gives a stationary representation of the light distribution in the image. Results are given and discussed for radial and tangential lines at various relative apertures and field angles and at different axial planes of focus.

535.317.7

6695. A FOURIER ANALYSER FOR OPTICAL FREQUENCY RESPONSE DETERMINATIONS. J.M.Naish.

Optica Acta, Vol. 6, No. 2, 152-7 (April, 1959).

The frequency response of an optical system may be derived from photoelectric image scanning data by a comparatively simple technique. The scanning movement is used to drive a sine-cosine potentiometer, fed by the photoelectric scanning signal, and integration of the product so formed is carried out with a low-inertia motor. Sine and cosine terms are available and the successive Fourier coefficients are obtained by an alteration of potentiometer gearing. Values obtained with the apparatus are compared with those resulting from an equivalent digital electronic computation.

535.317.7 : 535.417

6696. OPTICAL FREQUENCY RESPONSE CHARACTERISTICS IN THE PRESENCE OF SPHERICAL ABERRATION MEASURED BY AN AUTOMATICALLY RECORDING INTERFEROMETRIC INSTRUMENT. D.Kelsall.

Proc. Phys. Soc., Vol. 73, Pt 3, 465-79 (March, 1959).

An interferometric method is described which measures the frequency response characteristics of a lens, with automatic recording of the curves. The theory of the method is given, followed by a discussion of the problems arising in the design of the instrument. A new type of interferometer was devised, having very stable adjustment and permitting accurate control of the path length and relative lateral shear of the two interfering wave fronts. Using a double beam shearing interferometer, with corner cube reflectors, it was also possible to measure the spatial phase-shift term of the complex frequency response and record this automatically. The frequency response curves for a well-corrected lens in different focal planes have been compared with results obtained by Hopkins theoretically. The influence of primary spherical aberration on the frequency response has been studied in certain cases and the results of theoretical calculations verified.

535.323 : 539.213.2

REFRACTIVE INDICES AND DISPERSIONS OF SODIUM TITANIUM SILICATE GLASSES. See Abstr. 6300

535.33 : 539.17

6697. ROLE OF SPECTROSCOPY IN THERMONUCLEAR RESEARCH. J.R.McNally,Jr.

J. Opt. Soc. Amer., Vol. 49, No. 4, 328-37 (April, 1959).

The role of spectroscopy in thermonuclear research is reviewed briefly. The various techniques of observation and interpretation of spectra and some of the limitations are illustrated by appropriate tables and figures. It is shown that the spectroscopist has available a unique, multipurpose, and yet unperturbing probe which can contribute significantly to the interpretation of the pressing problems besetting thermonuclear scientists.

535.33.07

6698. HIGH-SENSITIVITY, RECORDING, SCANNING FLAME SPECTROPHOTOMETER. M.T.Kelley, D.J.Fisher and H.C.Jones.

Analyt. Chem., Vol. 31, No. 2, 178-83 (Feb., 1959).

The design and performance of a high-sensitivity, recording, wavelength-scanning, flame spectrophotometer are described. Considerations are discussed that govern choices of recorder, monochromator, multiplier phototube, and filter components. Special advantages of this instrument include gains in precision and in dependability resulting from the use of a chart recorder, the reduction of hazards arising from the analysis of radioactive samples, exceptional performance in the red spectral region, great stability and sensitivity, unusual operational versability, minimizing of anion and salt interferences by the high sample dilution possible, and reduction of spectral and flame background interferences by use of a good monochromator. Generally, the relative standard deviation for analyses is less than 1%, and linear calibration curves are obtained.

535.33.07

6699. WAVELENGTH MEASUREMENT IN ECHELLE SPECTRA. J.J.McNeill.

J. Opt. Soc. Amer., Vol. 49, No. 5, 441-5 (May, 1959).

A method for the accurate measurement of wavelength in echelle grams is described. It differs from previous methods in being applicable to a spectrograph with a continuosly variable projection-length, such as a variable wavelength Littrow lens spectrograph. Any line in an echelle spectrum is characterized by the ratio l/L, where L is the distance between two arbitrary marks at opposite ends of the prism spectrograph slit, and l is the distance of the echelle line from one of them. By fitting a quadratic curve to the known spectrum of neon, the "unknown" wavelengths of a mercury-cadmium spectrum are derived with an accuracy of better than 1 in 10^6. It is shown that a linear curve is adequate for certain complex spectra such as the absorption spectrum of bromine. Allowance can be made for line shifts due to thermal, mechanical, or pressure causes.

535.33.07

6700. INFRARED VACUUM SPECTROMETER WITH PRISM/GRATING DOUBLE MONOCHROMATOR. C.S.C.Tarbet and E.F.Daly.

J. Opt. Soc. Amer., Vol. 49, No. 6, 603-8 (June, 1959).

A prism/grating double monochromator was made in which the grating monochromator was ganged with a rocksalt monochromator on a linear frequency basis. Two replica gratings, each used in a single order, cover the range 650 cm^{-1} to 3650 cm^{-1}. Resolution is such that peaks with a separation of 0.3 cm^{-1} at 950 cm^{-1} may be resolved. Gratings and cams and also prisms may be interchanged by operation of press buttons. Similarly the instrument may be converted to a single prism monochromator to extend the frequency range. A constant energy background is provided by magnetically operated slits programmed by a tapped potentiometer. The double beam photometer uses a starwheel beam attenuator and is capable of good quantitative accuracy. The whole optical system is evacuable and a pressure of 10^{-3} mm Hg within the vacuum casing is satisfactory for accurate work at grating resolution.

535.33.07

6701. EXCITATION OF SPECTRA IN THE VACUUM REGION BY MEANS OF A LOW-PRESSURE PULSE DISCHARGE. F.Z.Pedos and N.S.Sventitskiĭ.

Optika i Spektrosk., Vol. 5, No. 6, 706-7 (1958). In Russian.

A low-pressure (10^{-4} mm Hg) pulse source, which can be used to excite spectra in the extreme ultraviolet region, is described. The source consisted of a chamber with two rod-shaped electrodes placed one above the other. The electrode ends were hemispherical

and the gap between them was 1.5 mm. An auxiliary carbon electrode was placed very close to the upper electrode in order to start a discharge. Pulses were produced by a capacitor bank (8000 μF, charged to 280 V); 250 pulses were required to record one spectrum.
A.Tybulewicz

535.33.07

6702. CONTRAST TRANSFER IN THE GRATING SPECTROGRAPH. A.Lohmann.
Optica Acta, Vol. 6, No. 2, 175-85 (April, 1959).

General formulae are calculated for the intensity distribution in a grating spectrograph with various types of grating error, with aperture diffraction, with proper aberrations and with amplitude filters. The calculations were based on the theory of contrast transfer for the optical image formation. This theory permits the calculation of the spectral distribution of the light falling into the entrance slit from the measured intensity distribution with the aid of the Fourier theorem. In this way, a maximum of information can be obtained. The theory can also be applied to less conventional spectrographs where the limit of resolution does not depend on the aperture diffraction in the usual way.

535.33.07

6703. GRATING SPECTROGRAPH FOR THE FAR ULTRA-VIOLET. APPLICATION TO THE STUDY OF PERTURBATIONS OF THE RESONANCE LINES OF MERCURY BY PRESSURE.
S.Robin and St.Robin.
Rev. Opt., Vol. 37, No. 4, 161-87 (April, 1958). In French.

Describes a vacuum concave grating instrument of 1 m radius of curvature, including equipment for absorption measurements. Measurements are reported of the broadening, displacement and appearance of satellite lines for 1850 and 2537 A, in emission and absorption at pressures up to some hundreds of atmospheres - using pure Hg and also additions of H_2, N_2, He, A and Xe. In the presence of Xe there is a satellite about 2 A on the long wave side of the 1850 A line; no satisfactory explanation of such satellites can be given.
G.F.Lothian

535.33.07

6704. MIRROR RAY PATHS FOR AN INFRARED SPECTROMETER.
W.Leo.
Z. InstrumKde, Vol. 66, No. 12, 239-44 (Dec., 1958). In German.

Discusses various arrangements of Littrow, Wadsworth and Pfund systems, including double monochromators, from the point of view of high resolution and freedom from aberrations.
G.F.Lothian

535.331

6705. INTERFERENCE MEASUREMENT OF THE WAVELENGTH OF SOME SPECTRAL LINES IN THE NEAR INFRARED BY MEANS OF A PHOTOELECTRIC CELL. T.Masui.
Rev. Opt., Vol. 36, No. 4, 171-6 (April, 1957). In French.

The method uses a Michelson interferometer, counting, by means of a photocell, the passage of fringes as the compensating plate is rotated. The arrangement is calibrated with known lines in visible and near infrared and then used to determine the wavelengths of the Hg line 1.014 μ and the Kr line 0.986 μ, both with an estimated precision of about 10^{-6} μ. The measurements reported are regarded as introductory only.
G.F.Lothian

535.332 : 523.873

6706. COLLISION BROADENING AND SHIFT IN THE RESONANCE LINE OF CALCIUM. W.R.Hindmarsh.
Monthly Not. Roy. Astron. Soc., Vol. 119, No. 1, 11-20 (1959).

The collision shift and broadening of the line Ca 4227 A due to an external pressure of helium were measured. The line was formed in absorption by passing white light through calcium vapour in the presence of helium at various pressures of less than 1 atm. The spectral resolution was provided by a Babcock grating used in the new Oxford solar spectrograph. The half-intensity damping width of the line was found to be $1.72 \pm 0.12 \times 10^{-20}\,\mathrm{cm}^{-1}$ per atom per cm^3 of helium, and the shift $0.05 \pm 0.04 \times 10^{-20}\,\mathrm{cm}^{-1}$ per atom per cm^3 towards the violet. The ratio of broadening to shift is therefore ≥ 19, compared with the value of 2.76 predicted by the Lindholm theory. The shift is also predicted to be towards the red. Possible explanations of the discrepancy are discussed and it is shown that the short-range repulsive forces between calcium and helium atoms must be involved as well as the long-range van der Waals forces. With the use of Lindholm's theory, coefficients for both types of force are evaluated from the measurements. Finally it is shown that the solar damping coefficient for Ca 4227 A is $< 2.2 \times 10^{-3}\,\mathrm{cm}^{-1}$ at $\tau = 0.1$, and that the collision shift makes a negligible contribution to the solar red shift.

535.332

6707. COLLISION SHIFTS IN THE ARGON SPECTRUM.
W.R.Hindmarsh and K.A.Thomas.
Monthly Not. Roy. Astron. Soc., Vol. 119, No. 1, 21-5 (1959).

The collision shifts of two argon lines, λ 7067 A and λ 6965 A, were measured, the lines being excited in a d.c. glow discharge in pure argon. The lines were examined by means of a Fabry—Perot interferometer crossed with a Hilger prism spectrograph. The interference ring diameters were measured for a variety of argon pressures and discharge currents. It is shown that the measured shifts were due to collisions between two argon atoms, and not to the influence of charged particles. The shift for λ 7067 is $-0.61 \pm 0.05 \times 10^{-20}\,\mathrm{cm}^{-1}$ per atom per cm^3 of argon, and for λ 6965 is $-0.65 \pm 0.05 \times 10^{-20}\,\mathrm{cm}^{-1}$ per atom per cm^3 of argon, where the negative sign indicates a red shift. These results are shown to imply that the short range repulsive forces between argon atoms can be of little importance in producing the shifts, in contrast to the case of the calcium line λ 4227 A perturbed by helium.

535.333

6708. ON THE MECHANISM OF THE LEWIS—RAYLEIGH NITROGEN AFTERGLOW. K.D.Bayes and G.B.Kistiakowsky.
J. chem. Phys., Vol. 29, No. 4, 949-50 (Oct., 1958).

Intensity measurements on isotopic bands of the first positive ($B^3\Pi$-$A^3\Sigma$) and the new Y (possibly $^3\Delta$-$B^3\Pi$) (see LeBlanc, Tanaka and Jursa, Abstr. 6810/1958) band systems of N_2, excited under the conditions of the Lewis—Rayleigh afterglow at liquid N_2 temperatures in the presence of A and Kr, suggest that vibrational relaxation may occur in the $B^3\Pi$ state.
R.W.Nicholls

535.333

6709. INFRARED EMISSION SPECTRA FROM A CARBON FURNACE. E.A.Ballik and D.A.Ramsay.
J. chem. Phys., Vol. 29, No. 6, 1418-19 (Dec., 1958).

High resolution studies in the 3000-9000 cm^{-1} region have revealed two new band systems. One — appearing above 2600°C — has been identified with a $^3\Sigma_g^- \rightarrow {}^3\Pi_u$ transition of the C_2 molecule. The other system which is observed in the presence of silicon is associated with SiC_2.
D.L.Greenaway

535.333

6710. BLUE NITRIC OXIDE AFTERGLOW.
C.A.Barth, W.J.Schade and J.Kaplan.
J. chem. Phys., Vol. 30, No. 1, 347-8 (Jan., 1959).

The authors report a change in the intensity distribution of the emission spectrum of the blue nitric oxide afterglow when helium is added to the afterglow mixture and discuss the implications of this sensitivity.
R.D.Hudson

535.333

6711. CHEMICALLY INDUCED MOLECULAR EXCITATION: EXCITATION SPECTRUM OF THE NITRIC OXIDE—OZONE SYSTEM. J.C.Greaves and D.Garvin.
J. chem. Phys., Vol. 30, No. 1, 348-9 (Jan., 1959).

The emission spectrum of the nitric oxide—ozone system has been investigated using 4% ozone in oxygen in an excess of nitric oxide at a pressure of 140 mm Hg. A complex system of unresolved bands between 5900 A and 10850 A, overlying an apparent continuum, has been observed and the authors discuss the possible origin of these bands.
R.D.Hudson

535.333

6712. EMISSION SPECTRUM OF TeO. R.L.Purbrick.
J. chem. Phys., Vol. 30, No. 4, 962-3 (April, 1959).

Emission bands were discovered on the long wavelength side of previously reported bands. Wavelengths, intensities and square arrays of the bands are given.

535.337 : 538.615 : 537.311.33

ZEEMAN TYPE MAGNETO-OPTIC STUDIES OF ENERGY BAND STRUCTURE. See Abstr. 5677

535.337 : 538.615 : 539.2

OPTICAL SPECTRUM AND MAGNETO-OPTICAL PROPERTIES OF EXCITONS. See Abstr. 6258

535.338

6713. INTENSITIES IN THE SPECTRA OF POLYATOMIC MOLECULES. B.S.Neporent and N.G.Bakhshiev.
Optika i Spektrosk., Vol. 5, No. 6, 634-45 (1958). In Russian.

The effect of a solvent on the magnitude of the absorption integral and the excited-state lifetime and the relationship between these two quantities in polyatomic molecules are discussed. It is

shown that the concept of the integral intensity of electron transitions can be applied unreservedly only to complex polyatomic molecules. For simple polyatomic molecules, the authors give conditions and limits within which this integral intensity still retains its physical sense. It is also shown that a solvent may be regarded as an external dielectric medium in the case of complex and some simple molecules. Various models of the system consisting of an absorbing molecule and a solvent are considered and it is found that the model in which a solvent is regarded as an isotropic medium which "impregnates" a molecule is untenable. Corrections for the effect of the internal field in a solution, which are necessary in order to obtain agreement between theoretical relationships relating the absorption integral and the excited-state lifetime of vapours and solutions of phthalimide and several of its derivatives and the experimental data, are given. The best agreement is obtained using the Onsager reactive field correction; somewhat poorer agreement is obtained when the Lorentz correction is applied.
A.Tybulewicz

535.338.32

6714. THE TIME RELAXATION OF A RESONANCE-LINE PROFILE. G.B.Field.
Astrophys. J., Vol. 129, No. 3, 551-64 (May, 1959).

The scattering of Lyman-α and other resonance lines is important for many astrophysical applications. The Zanstra effect, by which radiation is redistributed within the resonance-line profile, has a profound effect on the change of the profile in time and space. Here we study the time development of an isotropic radiation field as a clue to understanding the more complex transfer problem. It is found, by using previously unnoticed properties of the redistribution probability, that the time-dependent scattering equation for isotropic Doppler scattering with zero damping has an analytic solution; it amounts to progressive widening of the profile approximately as $(\log t)^{1/2}$ with a simultaneous flattening of the line centre. The effects of recoil due to the finite atomic mass are taken into account by a perturbation method and are shown to result in a slope $-h/kT$, for the central portion of the profile. The possibility of extending the analysis to the transfer problem is discussed. Applications are made to the excitation of the 21 cm line by Lyman-α.

535.338.334

6715. THEORY OF PRESSURE EFFECTS ON ALKALI DOUBLET LINES. L.Klein and H.Margenau.
J. chem. Phys., Vol. 30, No. 6, 1556-65 (June, 1959).

Experiments have revealed that pressures of noble gases cause bands to appear in both the red and violet wings of the alkali doublet lines. The present paper is devoted to the explanation of these bands and to the shift and shape of the doublet lines which they accompany. In order to examine various qualitative proposals previously put forth to this end, we first ascertain the validity of the statistical theory as applied to the magnetic substates of the alkali resonance lines and develop a criterion for adiabaticity. This criterion indicates that the earlier theories are inadequate. Shift and broadening of the two components of the alkali doublet lines are then calculated as functions of noble gas density by considering the van der Waals energy perturbation due to n simultaneously acting perturbers. The conclusion, which is in agreement with experiments, is that the $^2P_{3/2}$ resonance line is shifted and broadened more than the $^2P_{1/2}$ resonance line at moderate pressures. A phenomenological approach is used to construct a more reasonable theory of the "satellite" bands. In the absence of reliable knowledge concerning the repulsive portions of the interaction curves, only a semiquantitative understanding of the data is achieved.

535.338.4

6716. INTERNAL FIELD AND THE ABSORPTION BAND INTENSITIES IN SOLUTIONS. N.G.Bakhshiev.
Optika i Spektrosk., Vol. 5, No. 6, 646-54 (1958). In Russian.

A general form of the relationship between the internal field and the absorption band intensity is discussed in the case of solutions. A simplified expression, based on the Onsager–Böttcher theory, is obtained for the correction for the effect of a solvent. The oscillator strength is found to contain a certain parameter $\bar{\alpha}_j/r_j^3$, where $\bar{\alpha}_j$ is the mean value of the real part of complex polarizability of an absorbing molecule in the region of the latter's absorption band, and r_j is the radius of a sphere of action of the internal field at this molecule. According to Onsager the parameter $\bar{\alpha}_j/r_j^3$ determines the change in absorption on transition from vapours to solutions. The author calculated values of the $\bar{\alpha}_j/r_j^3$ parameter for seven aromatic compounds in solution; its value was found to increase with molecular dimensions. A.Tybulewicz

535.338.42

6717. INTENSITY FORMULAE FOR $^7\Pi \leftrightarrow {}^7\Sigma$ BAND.
I.Kovács and O.Scari.
Acta phys. Hungar., Vol. 9, No. 4, 423-43 (1959).

Explicit expressions are given for the intensity distribution occurring in the branches of bands $^7\Pi(a) \leftrightarrow {}^7\Sigma$, $^7\Pi(b) \leftrightarrow {}^7\Sigma$. The intensity distribution, calculated on the basis of the established formulae, is compared with measurements carried out on the $^7\Pi \leftrightarrow {}^7\Sigma$ bands of MnH, and relatively good agreement is found.

535.34 : 539.2

LOW-FREQUENCY LIBRATIONS AND THE VIBRATIONAL SPECTRA OF MOLECULAR CRYSTALS. See Abstr. 6233

535.343

6718. SPECTROSCOPY OF THE SOLID BODY AND EXCITON SPECTRA. S.Nikitine.
J. Phys. Chem. Solids, Vol. 8, 190-3 (Jan., 1959). In French.

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Three different classes of absorption line spectra are found in solids at low temperatures. Those typical of (1) CuI and (2) Cu_2O are of exciton origin, and the transitions responsible are discussed. The third class shows more variation in detail than the others and is likely to depend on lattice defects. S.T.Henderson

535.343

6719. ABSORPTION SPECTRUM OF NITRIC OXIDE. FINE STRUCTURE ANALYSIS OF THE δ- AND β-BANDS AND OF THE HOMOGENEOUS PERTURBATION $C^2\Pi - B^2\Pi$.
A.Lagerqvist and E.Miescher.
Helv. phys. Acta, Vol. 31, No. 3, 221-62 (1958). In German.

The absorption spectrum is studied from plates obtained with the Ottawa 3 m and the Chicago 6 m vacuum spectrographs. Rotational analyses are given for 5 bands [(0,0), (1,0), (2,0), (3,0) and (4,0)] of the δ-system ($C^2\Pi - X^2\Pi$) and for 15 bands [(5,0)-(19,0)] of the β-system ($B^2\Pi - X^2\Pi$) in the wavelength region 1980-1590 A. The $B^2\Pi$ and $C^2\Pi$ excited states show a strong and extended mutual perturbation of the homogeneous type as a consequence of the crossing of the two corresponding potential energy curves. The perturbation parameter H is calculated and has a pronounced maximum if plotted against the excitation energy. In order to explain quantitatively the observed vibrational and rotational perturbations a "deperturbation" in first and second approximation is carried out on the basis of perturbation theory and the H-curve. This unusually fine example of a perturbation in bandspectra is compared with hitherto known cases for the AgH and PbH molecules. The observed anomalous vibrational and rotational isotope shifts in the perturbed bands are thoroughly discussed.

535.343

6720. FORBIDDEN BAND SYSTEMS IN NITROGEN. I. THE VEGARD—KAPLAN SYSTEM IN ABSORPTION. P.G.Wilkinson.
J. chem. Phys., Vol. 30, No. 3, 773-6 (March, 1958).

Two bands belonging to the Vegard—Kaplan system ($A^3\Sigma_u^+ - X^1\Sigma_g^+$) of nitrogen were found in absorption in paths of 9-13 meter-atmospheres. These bands at 1689 A(7-0) and 1726(6-0) are incompletely resolved but show intensity alternation and distribution in agreement with theory. The positions of the band origins and each rotational line agree closely with those calculated from the known molecular constants. Two other forbidden systems were found in absorption. These are the $a'^1\Sigma_u^- - X^1\Sigma_g^+$ (four bands at 1444, 1414, 1360, and 1331 A) and probably the $^3\Delta_u - X^1\Sigma_g^+$ (one band at 1484 A); they are about three times stronger than the observed Vegard—Kaplan bands. The transition probabilities of the known forbidden systems in nitrogen are discussed briefly.

535.343

6721. EFFECT OF PRESSURE ON SOME CHARGE TRANSFER SPECTRA. D.R.Stephens and H.G.Drickamer.
J. chem. Phys., Vol. 30, No. 6, 1518-20 (June, 1959).

The charge transfer spectra of $[Co(NH_3)_5I]I_2$, K_2ReCl_6, K_2ReBr_6, quinhydrone, and chloranil-hexamethyl-benzene have been measured as a function of pressure. The shifts of the peaks for the inorganic complexes can be explained in terms of the effect of pressure on the acceptor levels of the metal relative to the ligand levels. The large red shifts observed in the peaks for the organic complexes can be explained in terms of solid-state band theory.

535.343 : 539.2

ABSORPTION SPECTRA OF Cu_2O. See Abstr. 6253

535.343 : 537.312.5

OPTICAL INVESTIGATION OF SEMICONDUCTORS.
See Abstr. 5718

535.343

6722. OPTICAL PROPERTIES OF ALKALI HALIDES CONTAINING HYDROXYL IONS.

H.W.Etzel and D.A.Patterson.
Phys. Rev., Vol. 112, No. 4, 1112-16 (Nov. 15, 1958).

The optical absorption spectra of single crystals of sodium chloride, potassium chloride, and potassium bromide from various sources were measured from the visible region to the fundamental edge. Bands are found at 185 mμ in NaCl, at 204 mμ in KCl, and at 214 mμ in KBr. The positions of the bands satisfy an Ivey relation, $\lambda = 691d^{0.95}$, where d is the lattice parameter in angstroms. These bands are associated with the presence of hydroxyl ions in the lattice. When NaCl is additively coloured, a hydride ion absorption (U-band) appears which is proportional to the 185 mμ band absorption in the crystal before coloration. The F-band produced in NaCl and KCl by ionizing radiation is also proportional to the initial hydroxyl ion band absorption. It is found that the hydroxyl ion absorption band can be removed by the addition of certain impurities to the melt.

535.343

6723. STUDY OF THE EFFECTS OF SUBSTITUTION ON THE ABSORPTION SPECTRA OF PORPHIN.

M.Gouterman.
J. chem. Phys., Vol. 30, No. 5, 1139-61 (May, 1959).

A model is presented for the excited states of porphin, which are viewed as arising from two configurations which can be mixed to varying degrees. The effects of substituents are then discussed, first the limitations imposed by symmetry requirements and then the requirements imposed if they act as one electron perturbations. The theory is applied to certain experimental problems. First it is shown how the metal porphins can be viewed as a series showing increasing mixing of the two fundamental configurations. Next the effect of free base formation is explained as a cyclic polyene perturbation. This theory predicts that the lowest porphin transition is polarized parallel to the H—H axis. Formulae are derived for intensity changes caused by various external substituents; their effect on transition energies are also discussed. Finally formulae are developed to account for the effects of aza substitution on the methine bridges.

535.343

6724. ELECTRIC FIELD INDUCED VIBRATION ROTATION SPECTRUM OF H_2 AND D_2.

R.W.Terhune and C.W.Peters.
J. molecular Spectrosc., Vol. 3, No. 2, 138-47 (April, 1959).

Electric field induced absorption was observed for some eight vibration—rotation transitions of H_2 and for seven of D_2. An alternating electric field was used to modulate the transmitted intensity. Percentage absorptions as small as one part in 30 000 were observed with a resolution of 1 cm^{-1} at 4000 cm^{-1}. From intensity measurements, the values of several polarizability matrix elements were deduced. All results were consistent with previous measurements on H_2 and D_2 and support the theory as developed by Condon.

535.343

6725. THE INFRARED SPECTRUM OF LIQUID AND SOLID HYDROGEN.

E.J.Allin, H.P.Gush, W.F.J.Hare and H.L.Welsh.
Nuovo Cimento Suppl., Vol. 9, No. 1, 77-83 (1958).

Infrared spectra of liquid and solid hydrogen over the range 4100-5500 cm^{-1} were obtained using a high resolution grating spectrometer, and a considerable amount of new detail observed. A small but abrupt change has been detected at the fusion point, but the similarity of spectra of solid and liquid indicates short range order in the liquid, very similar to that in the solid, just above the fusion point. Certain features of the S lines in the fundamental band of the solid are ascribed to double transitions, in which one molecule performs the vibrational transition and a second performs simultaneously a rotational transition in its ground vibrational state. The predominance of these transitions is discussed with reference to the theory of induced absorption in dense gases. The effect of altering the ortho-para ratio of solid hydrogen has also been investigated and the observed changes in spectral intensity distribution correlated with the molecular arrangement.

D.L.Greenaway

535.343

6726. INFRARED SPECTRUM OF BF_3.

J.Vanderryn.
J. chem. Phys., Vol. 30, No. 1, 331-2 (Jan., 1959).

Spectra of BF_3 in the region 1450-3300 cm^{-1}, have been obtained which leave no uncertainties as to the assignments of the observed bands. The positions of the bands, their assignments and the calculated values for overtone and combination frequencies are given.

D.L.Greenaway

535.343

6727. INFRARED SPECTRUM OF $Mg(OH)_2$.

H.A.Benesi.
J. chem. Phys., Vol. 30, No. 3, 852 (March, 1959).

Spectra in the 3000-5000 cm^{-1} region of finely powdered samples of $Mg(OH)_2$ show the presence of an extremely intense absorption band at 3698 cm^{-1}, presumably arising from the (OH) stretching fundamental, superimposed on a number of weak satellite bands. There is a 300-fold difference in maximum absorptivity between the two types of bands.

D.L.Greenaway

535.343

6728. INTERPRETATION OF THE INFRARED SPECTRA OF THE SOLID HYDROXYLAMMONIUM HALIDES.

D.L.Frasco and E.L.Wagner.
J. chem. Phys., Vol. 30, No. 5, 1124-30 (May, 1959).

Infrared spectra of sublimed films of hydroxylammonium and deuterohydroxylammonium chlorides, bromides, and iodides have been obtained at 25°, −78°, and −180°C from 4000 to 400 cm^{-1}. Satisfactory vibrational assignments for the hydroxylammonium ion can be made on the basis of an ionic model in which one end of the ion (H_3NO) is axially symmetric (C_{3V}) and the other end (OH) is of C_s symmetry. A normal coordinate treatment based on a simplified valence force potential with ten constants reproduces 13 of the 18 frequencies of the hydroxylammonium and deuterohydroxylammonium ions to better than 2% and all 18 frequencies to better than 5%. The low NH and OH frequencies are believed to be due to the formal positive charge being distributed over all the atoms in the ion thereby weakening the covalently bonded H atoms and increasing the strengths of the electrostatic hydrogen bonds.

535.343

6729. PURE ROTATIONAL ABSORPTION OF OZONE AND SULFUR DIOXIDE FROM 100 TO 200 MICRONS.

A.Danti and R.C.Lord.
J. chem. Phys., Vol. 30, No. 5, 1310-13 (May, 1959).

Pure rotational absorption spectra of ozone and sulphur dioxide (100-200 microns) were correlated with the microwave reciprocal moments and the distortion constants through Polo's first-order treatment of centrifugal distortion. A small grating spectrometer was used to record five weak Q branches of O_3 and about eight due to SO_2. The SO_2 spectrum is complicated by relatively strong associated P and R branch lines. The values of the most important distortion constant, D_K, are found to be 1.96×10^{-4} and 7.61×10^{-5} for O_3 and SO_2, respectively. The respective values calculated from the centrifugal distortion constants are 1.95×10^{-4} and 8.54×10^{-5} cm^{-1}. The five other distortion terms were also calculated. The ease of obtaining reasonably accurate molecular constants from far infrared investigations is pointed out and theoretical treatment of SO_2 is suggested.

535.343

6730. FREQUENCY SHIFTS IN THE INFRARED ABSORPTION SPECTRUM OF COMPLEX IONS IN SOLID SOLUTION.

J.A.A.Ketelaar and J. van der Elsken.
J. chem. Phys., Vol. 30, No. 1, 336-7 (Jan., 1959).

The differences in the spectra of complex ions in solid solutions and the pure salts of the ions can be explained by assuming polarization of the solid solution matrix. Results for ions such as BF_4^-, NO_3^-, and NH_4^+, in alkali halide matrices show that the observed frequency shifts become a simple function of the matrix lattice parameter through the application of a polarization correction.

D.L.Greenaway

535.343 : 539.21

6731. INFRARED ABSORPTION IN NEUTRON IRRADIATED SILICON.

H.Y.Fan and A.K.Ramdas.
J. Phys. Chem. Solids, Vol. 8, 272-4, 285 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Absorption bands at 3.3, 3.9, 6.0 and 20.5 μ are caused by neutron irradiation. The experimental data are summarized. It is found that the optical activation energy is greater than the thermal ionization energy for the defects introduced by the irradiation.

C.A.Hogarth

535.343

6732. ELECTRONIC ABSORPTION BANDS OF ZnO AND TiO_2 IN THE INFRARED REGION.

V.N.Filimonov.
Optika i Spektrosk., Vol. 5, No. 6, 709-11 (1958). In Russian.

ZnO powder layer of 5-10 mg/cm^2 thickness was irradiated with ultraviolet light in vacuo. This treatment removed adsorbed oxygen and in consequence ZnO exhibited absorption of infrared wavelengths between 2500 and 500 cm^{-1}. This infrared absorption is due an increase in the number of conduction electrons on removal of O_2 and due to transitions in the conduction band. Similar effects are observed when TiO_2 is irradiated with ultraviolet in vacuo.

A.Tybulewicz

535.343

6733. INFRARED SPECTRUM OF HEXACHLOROBENZENE.

R.Kopelman and O.Schnepp.

J. chem. Phys., Vol. 30, No. 2, 597-8 (Feb., 1959).

Results obtained on single crystals and on benzene solutions are tabulated and interpreted but no conclusions concerning the structure of the hexachlorobenzene molecule are reached.

G.I.W.Llewelyn

535.343

6734. INFRARED SPECTRUM OF THE DIMETHYLNITRILIUM ION.

G.C.Turrell and J.E.Gordon.

J. chem. Phys., Vol. 30, No. 5, 895-8 (April, 1959).

The infrared spectrum of the dimethylnitrilium ion is presented and discussed. Thirteen of the fifteen infrared active fundamentals expected for the ion on the basis of a C_{3V}' structure are assigned, and the frequencies of the two remaining fundamentals are estimated from observed combination bands. A calculation of the skeletal bond stretching and bending force constants is given.

535.343 : 535.375.5 : 536.71

THERMODYNAMIC AND SPECTROSCOPIC STUDY OF VINYLIDENE CHLORIDE. I. See Abstr. 6861

535.343 : 535.375.5 : 536.71

6735. THERMODYNAMIC AND SPECTROSCOPIC STUDY OF VINYLIDENE CHLORIDE. II. VIBRATIONAL SPECTRA.

J.C.Evans.

J. chem. Phys., Vol. 30, No. 4, 934-6 (April, 1959).

The Raman spectra of vinylidene chloride liquid, excited by the 5461-A line and the 4358-A group of lines of the mercury arc, were recorded photoelectrically and some depolarization measurements made. The infrared spectrum of the vapour in the 700-320 cm^{-1} region was also recorded. These data have enabled some uncertainties in the published vibrational assignment to be resolved but they do not indicate the need for major changes in this assignment.

535.343

6736. INFRARED SPECTRA OF ALKOXYBORANES. I. DIMETHOXYBORANE AND DIMETHOXYBORANE-D.

W.J.Lehmann, T.P.Onak and I.Shapiro.

J. chem. Phys., Vol. 30, No. 5, 1215-18 (May, 1959).

Frequency assignments are made, based on the infrared spectra of gaseous $HB(OCH_3)_2$ and $DB(OCH_3)_2$. A band previously reported in the literature for trimethoxyborane is attributed to an impurity.

535.343

6737. INFRARED SPECTRA OF ALKOXYBORANES. II. CHLORODIMETHOXYBORANE AND DICHLOROMETHOXYBORANE.

W.J.Lehmann, T.P.Onak and I.Shapiro.

J. chem. Phys., Vol. 30, No. 5, 1219-22 (May, 1959).

Infrared spectra of gaseous $ClB(OCH_3)_2$ and Cl_2BOCH_3 in the 2 to 15 μ range are reported, and the observed bands are assigned to the fundamental vibrations of the molecules. The single B—Cl vibration was found to have widely varying frequencies and thus cannot be described by the term "characteristic". Two strong bands, reported by previous investigators at 1376 and 1395 cm^{-1} in the infrared spectrum of BCl_3 have been found to be due to an impurity. By use of a correlation scheme assignments for some skeletal stretching vibrations in $FB(OCH_3)_2$ are proposed.

535.343

6738. INFRARED SPECTRA OF ALKOXYBORANES. III. DI- AND TRIETHOXYBORANES.

W.J.Lehmann, H.G.Weiss and I.Shapiro.

J. chem. Phys., Vol. 30, No. 5, 1222-6 (May, 1959).

Frequency assignments are made for the infrared spectra of gaseous triethoxyborane, diethoxyborane, and diethoxyborane-d. A new experimental technique was applied in an effort to detect transitory intermediates in the alcoholysis of diborane; no monoethoxyborane was detected. When alcohol was added to diborane, triethoxyborane appeared only after all diborane had been converted to diethoxyborane. Transfer of ethoxy groups between boron atoms is slow, while hydrogen exchange is rapid.

535.343

6739. INFRARED SPECTRA OF ALKOXYBORANES. IV. DI- AND TRIISOPROPOXYBORANES.

W.J.Lehmann, H.G.Weiss and I.Shapiro.

J. chem. Phys., Vol. 30, No 5, 1226-31 (May, 1959).

Frequency assignments are made, based on the infrared spectra of gaseous di- and triisopropoxyboranes. Correlation with spectra of other alkoxyboranes shows that the BO_3 asymmetric stretching frequency is higher than the value previously assigned in the literature. Identification of the C—O stretching frequency in the 1050-1150 cm^{-1} range supports the interpretation that this region (rather than ~1300 cm^{-1}) represents the C—O vibration in alcohols.

535.343

6740. VIBRATIONAL SPECTRA OF PRIMARY AND SECONDARY ALIPHATIC AMINES.

J.E.Stewart.

J. chem. Phys., Vol. 30, No. 5, 1259-65 (May, 1959).

The infrared absorption spectra of twenty primary and thirteen secondary amines have been studied. A strong band, assigned to the asymmetric C—N stretching mode of secondary amines, is found at 1139 ± 7 cm^{-1} in compounds having a primary alpha carbon and at 1181 ± 10 cm^{-1} in compounds having a secondary alpha carbon. The primary amines have a corresponding C—N band at 1079 ± 11, 1040 ± 3, and 1030 ± 8 cm^{-1} for compounds with primary, secondary and tertiary alpha carbons, respectively. A strong broad band is found at 739 ± 11 and 718 ± 18 cm^{-1} in the spectra of secondary amines having primary and secondary alpha carbons. This absorptic is assigned to the N—H bending mode. In liquid primary amines, pairs of strong bands at 778 ± 15 and 825 ± 15, 794 ± 16 and 840 ± 1 and 776 ± 8 and 833 ± 18 cm^{-1} are assigned to the symmetric and asymmetric NH_2 bending modes in compounds having primary, secondary and tertiary alpha carbon atoms, respectively. Shifts in frequency of some of these bands are noted in the gas phase or in solution. A very strong, broad band centred at less than 290 cm^{-1} is observed in the spectra of the primary amines, but not the secondary amines. This band disappears in the gas phase and is assigned to the torsional oscillation of the $—NH_2$ group. A simplified normal coordinate treatment of the $R—NH_2$ and $R_2—NH$ vibrations is given in support of the assignments.

535.343 : 535.375.

6741. INFRARED AND RAMAN SPECTRA OF FLUORINATED ETHANES. XI. PENTAFLUOROBROMOETHANE.

P.Klaboe and J.R.Nielsen.

J. chem. Phys., Vol. 30, No. 6, 1375-9 (June, 1959).

For Pt X, see Abstr. 122 (1958). The infrared spectrum of gaseous $CF_3—CF_2Br$ was obtained with a Perkin—Elmer double-pas spectrometer equipped with CsBr, NaCl, and LiF prisms. The Raman spectrum of the liquid was photographed with a 3-prism glass spectrograph of reciprocal linear dispersion 15 A/mm at 4358 A. Seventeen vibrational fundamentals have been assigned as follows: species a': 1339, 1240, 1124, 949, 754, 634, 547, 370, 329, ~297, and ~167 cm^{-1}; species a'': ~1240, 1182, 591, 440, ~297, and ~152 cm^{-1}. The torsional fundamental, which undoubtedly lies below 150 cm^{-1}, could not be determined. The spectra are interpreted in detail.

535.343 : 539.1

6742. VIBRATIONAL SPECTRUM OF 4,4-DIMETHYLCYCLOPENTENE.

J.L.Lauer, W.H.Jones, Jr and H.C.Beachell.

J. chem. Phys., Vol. 30, No. 6, 1489-93 (June, 1959).

The vibrational analysis of 4,4-dimethylcyclopentene has been carried out by a normal coordinate calculation based on the Wilson FG matrix method. Assignments of the infrared and Raman bands were made with the help of the calculated fundamentals. The model used in the calculation was assumed to be planar and to possess C_{2v} symmetry. The good agreement between calculated and observed frequencies justified this assumption. A matrix iteration programme was used on an IBM-650 digital calculator to find the roots of the secular determinant. It worked very well considering the large number of modes caused by the low symmetry of the molecule

535.343 : 539.1

INFRARED STUDIES ON THE HYDROGEN BOND BETWEEN PHENOL AND SOME PROTON ACCEPTORS. See Abstr. 6204

535.34

6743. STARK EFFECT IN THE MICROWAVE SPECTRUM OF NITROSYL BROMIDE.

D.F.Eagle, T.L.Weatherly and Q.Williams.

J. chem. Phys., Vol. 30, No. 2, 603-4 (Feb., 1959).

The Stark effect for the J = 2 → 3 transition of NOBr has been nvestigated to determine the molecule dipole moment. The best greement of the calculated with the observed splittings is btained assuming a value of μ_a = 1.80 debye. G.I.W.Llewelyn

535.343 : 535.337

744. ZEEMAN EFFECT IN THE 1- TO 3-MILLIMETER WAVE EGION: MOLECULAR g FACTORS OF SEVERAL LIGHT MOLE-ULES. C.A.Burrus.

. chem. Phys., Vol. 30, No. 4, 976-83 (April, 1959).

The Zeeman effect was observed in the microwave rotational pectra of several light molecules, and the high-frequency limit of uch measurements was extended for the first time to 1.1 mm wave-ength. The magnitudes of the molecular g factors g_J and, where pplicable, the components of the g tensor lying along the principal xes of rotation, were obtained for DBr, DI, CO, PH_3, PD_3, SO_2, O_3, $_2S$, HDS, and D_2S. When combined with information from other ources the data permitted, in addition, a determination of the sign f g_J for DBr and DI, and of the sign of the electric dipole moment f DI.

535.343

745. MICROWAVE SPECTRUM OF METHYL GERMANE.

.W.Laurie.

. chem. Phys., Vol. 30, No. 5, 1210-14 (May, 1959).

The J = 0 → 1 and 1 → 2 transitions of 28 isotopic species of H_3GeH have been measured. From the rotational constants btained, the following structural parameters have been calculated: CH = 1.083 ± 0.005 A°, rGeH = 1.529 ± 0.005 A°, rCGe = 1.9453 ± 0.005 A°, ∢HCH = 108° 25′ ± 30′, ∢HGeH = 109° 15′ ± 30′. The = 1 transitions of the asymmetrically deuterated species are plit by internal rotation about the C—Ge bond. With the assumption f a threefold sinusoidal potential, an internal barrier of 1239 ± 25 al/mole has been determined from these splittings. Analysis of he Stark effect of several species gives a dipole moment of .635 ± 0.006 D. From observed hyperfine structure the nuclear uadrupole coupling constant of Ge^{73} has been calculated to be 3 Mc/s.

535.343 : 539.19

746. MICROWAVE SPECTRUM, BARRIER TO INTERNAL OTATION, AND STRUCTURE OF METHYL FORMATE.

.F.Curl, Jr.

. chem. Phys., Vol. 30, No. 6, 1529-36 (June, 1959).

Rotational constants have been assigned to the following isotopic pecies of methyl formate by investigation of their microwave pectra: $HCOOCH_3$, $DCOOCH_3$, $HCOOCH_2D$, $HCOOCD_3$, $HC^{13}OOCH_3$, $COOC^{13}H_3$, $HCO^{18}OCH_3$, and $HCOO^{18}CH_3$. The following structural arameters were obtained from these rotational constants: (C=O) = 1.200 ± 0.01 A, r(C—O carboxyl) = 1.334 ± 0.01 A, (C—O methoxyl) = 1.437 ± 0.01 A, r(C—H carboxyl) = 1.101 ± 0.01 A, (C—H methyl) = 1.086 ± 0.015 A, ∠O=C—O = 125° 52′ ± 1°, H—C—O (carboxyl) = 109° 18′ ± 1°, ∠C—O—C = 114° 47′ ± 1°, and H—C—H = 110° 40′ ± 1.5°. The carbon-oxygen skeleton is planar with e methyl group cis to the carboxyl oxygen. The methyl group axis has een assumed to be along the C—O (methoxyl) bond, although some vidence suggests that it may be tilted. The barrier to internal otation of the methyl group was calculated from the splitting observed in the rotational transitions of the ground torsional state for everal isotopic species and found to be 1190 ± 40 cal/mole. The ipole moment was calculated from the observed Stark effect and und to be 1.77 ± 0.03D. The dipole moment lies at an angle of 9.4 ± 2° from the C=O bond and roughly on the line between the ster oxygen and the carboxyl oxygen.

535.343.9 : 535.375.5

747. RAMAN SPECTRUM AND STRUCTURE OF IRON PENTA-ARBONYL. H.Stammreich, O.Sala and Y.Tavares.

. chem. Phys., Vol. 30, No. 3, 856-7 (March, 1959).

Using He lines 6678 and 7065 A as source, 13 Raman lines are ound and listed. This is to be expected if the molecule has a trional bipyrimidal structure with point group D_{3h}. G.F.Lothian

535.343.9 : 535.375.5

748. INTENSITY IN THE RAMAN EFFECT. VI. THE PHOTO-LECTRICALLY RECORDED RAMAN SPECTRA OF SOME GASES.

.Yoshino and H.J.Bernstein.

. molecular Spectrosc., Vol. 2, No. 3, 213-40 (June, 1958).

A method is described for obtaining high quality photoelectrically ecorded Raman spectra of gases at pressures of 1 to 2 atm. fficient intensity was obtained by the use of a multiple reflection ell and six watercooled mercury arcs, each carrying 20 A. All the orrections required for obtaining true intensities and depolarization ratios from those observed were evaluated experimentally. Comparison of the theoretical values of intensity ratios of hydrogen rotational lines, the H_2 and D_2 vibrational lines, and the depolarization ratio of the symmetrical CC stretching band of neopentane with those observed in the present setup (after being corrected) show that the method presented for obtaining the true intensity is not in error by more than a few per cent. The intensities and depolarization ratios of the Raman bands for some simple molecules were measured. It was possible to assign the Raman spectrum of the bands in the 1950 cm^{-1} region in acetylene from intensity considerations, and a definitive value for the anharmonicity constant X_{24} is obtained and an upper limit given for X_{25}. A simple model is discussed by which the Raman intensity of the totally symmetrical stretching band in the hydrides H_nY, and the polarizabilities of these molecules, may be estimated. The present theory of the Raman effect is applicable only to molecules in the gas phase at relatively low pressure. Gas spectra have been obtained photographically where long exposure can compensate for the weak intensity of the Raman scattering; however, such spectra yield, in general, poor Raman intensity data. The photoelectric method of recording Raman spectra of gases is a more accurate means of obtaining the intensities of the Raman bands, but it has been difficult to put into practice because of the low intensity of the Raman scattering. A method is described for obtaining photoelectrically recorded Raman spectra of gases of sufficiently high quality to make possible good intensity and depolarization measurements. The results for some simple molecules are presented and discussed.

535.345

6749. INFRARED ABSORPTION IN ZINC OXIDE CRYSTALS.

D.G.Thomas.

J. Phys. Chem. Solids, Vol. 10, No. 1, 47-51 (April, 1959).

Optical absorption in the 1-12 μ region was observed in single crystals of ZnO at 300 and 78°K. Lattice bands are observed at 10.1 and 11.5 μ at 300°K. It is likely that impurities also cause some absorption. Strong absorption can arise from the presence of free electrons, and by using crystals doped with lithium or indium, this absorption was measured as a function of electron concentration and wavelength. At constant wavelength the absorption is proportional to the electron concentration, and for $\lambda < 6\ \mu$ at constant electron concentration, the absorption varies as λ^3.

535.345

6750. THE OPTICAL ABSORPTION EDGE IN IONIC CRYSTALS.

W.Martienssen.

J. Phys. Chem. Solids, Vol. 8, 294-6, 302-4 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Summarizes data on ionic crystals, in particular KI and TlCl, for which much of the edge absorption is due to exciton formation rather than band-to-band transitions as in the case of covalent crystals and semiconductors. Deviations from normal behaviour, which are observed at low temperatures, are discussed. C.A.Hogarth

535.345

6751. TEMPERATURE DEPENDENCE OF THE OPTICAL BAND GAP IN ZnS. W.W.Piper, P.D.Johnson and D.T.F.Marple.

J. Phys. Chem. Solids, Vol. 8, 457-61, 484-5 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Hexagonal ZnS crystals were grown from the vapour phase, and curves are given of the absorption coefficient v. photon energy for light polarized perpendicular or parallel to the c-axis. Peaks occur in the absorption at 3107, 3155, 3179 and 3202 A at 4°K. The temperature shift does not alter the curve shape up to 5000 cm^{-1} and is independent of the direction of polarization. The shifts of the position of the 3179 A line, and of frequencies corresponding to definite values of the absorption coefficient in the continuous band, have been compared with calculations based on the sum of the lattice dilatation effect and the electron-phonon interaction (with m^*/m_0 = 3.3 for electrons and holes). Previous measurements at room temperature and above agreed with the calculation, but the new determinations do not agree between 150° and 20°K. This may be due to electron scattering by piezoelectric acoustical modes in the crystal. S.T.Henderson

535.345

6752. THE ABSORPTION EDGE SPECTRUM OF DIAMOND.

C.D.Clark.

J. Phys. Chem. Solids, Vol. 8, 481-4, 484-5 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The changes in the optical absorption of diamonds in the energy range 4.9 to 5.6 eV have been measured as a function of temperature between 80° and 650°K. After correction for the temperature-independent impurity absorption, two temperature-dependent branches, attributed to indirect transitions into conducting and exciton states of the crystal, are observed. The absorption curves are analysed, and an equation describing the absorption as a function of photon energy and temperature is derived. J.B.Birks

535.345

6753. FUNDAMENTAL OPTICAL ABSORPTION IN MAGNESIUM OXIDE. G.H.Reiling and E.B.Hensley.

Phys. Rev., Vol. 112, No. 4, 1106-11 (Nov. 15, 1958).

The optical absorption and reflectivity of single crystals of MgO and the optical absorption of thin films of MgO, both supported by a LiF substrate and unsupported, were measured in the energy range from 6 to 13.5 eV. Absorption peaks due to impurities were observed at 6.0, 6.3 and 6.9 eV. The room-temperature fundamental absorption and reflectivity spectra are interpreted in terms of an exciton peak at 7.6 eV, with a probable second peak at 8.8 eV. Some evidence is present for additional exciton structure on the low energy side of the first peak. The width of the forbidden energy band in MgO is estimated to be about 8.7 eV. The effects of temperature and internal strains on the absorption spectra are discussed.

535.345 : 537.311.33

6754. EFFECT OF PRESSURE ON THE INFRARED ABSORPTION OF SEMICONDUCTORS. L.J.Neuringer.

Phys. Rev., Vol. 113, No. 6, 1495-1503 (March 15, 1959).

Measurements have been made of the effect of hydrostatic pressure upon the intrinsic infrared absorption of germanium, silicon, and tellurium in the pressure range 1-2000 atm. In germanium the variation with pressure of the lowest lying conduction band minimum, (111), is found to be $(7.3 \pm 1.5) \times 10^{-6}$ eV/atm. It is suggested that the variation with pressure of the next highest conduction band edge, (000), has a value of $(11 \pm 3) \times 10^{-6}$ eV/atm. The shift of the infrared absorption edge with pressure in silicon is small and is toward smaller energy, amounting to about -2×10^{-6} eV/atm between 1 and 2020 atm. The sign and magnitude of the pressure coefficient in this material are in agreement with the results of Warschauer, Paul and Brooks. For tellurium both $E_{g\perp}$, the energy gap corresponding to light polarized perpendicular to the c-axis of the crystal, and $E_{g\parallel}$, the energy gap for polarization parallel to the c-axis, decrease as the pressure is increased. It appears that $E_{g\perp}$ decreases more rapidly with pressure than $E_{g\parallel}$. The mean pressure coefficient of $E_{g\parallel}$ is $-(2.2 \pm 0.4) \times 10^{-6}$ eV/atm. For $E_{g\parallel}$ the mean pressure coefficient is $-(1.8 \pm 0.3) \times 10^{-6}$ eV/atm. The measured pressure coefficients are used to calculate the thermal dilation term in the equation for the change of the energy gap with temperature for each material. The electron–lattice interaction term appearing in this equation is then deduced. In silicon these two terms are of opposite sign with the electron–lattice term dominant. In germanium the electron–lattice interaction effect accounsts for 75% of the effect of temperature on the energy gap. For tellurium the two effects are almost equal in magnitude but of opposite sign.

535.345

6755. ANOMALOUS SPECTROPHOTOMETRIC BEHAVIOR OF COPPER PHTHALOCYANINE–BENZIDINE YELLOW MIXTURES. A.Di Bernardo and P.Resnick.

J. Opt. Soc. Amer., Vol. 49, No. 5, 480-4 (May, 1959).

Spectrophotometric reflectance curves of mixtures of copper phthalocyanine and benzidine yellow dispersions differed radically from the spectra that would be expected from a combination of these two pigments. Early tests on mixtures of the two pigment dispersions indicated that some sort of interaction was taking place. Microscopic examination eliminated flocculation and further tests showed that this unusual curve shape could not be attributed to a crystal transformation of the phthalocyanine blue. It is concluded that the anomaly can best be explained by a solvation effect of the benzidine yellow on the phthalocyanine blue.

535.345.6 : 539.18

6756. APPLICATION OF AN INTERFERENCE-POLARIZATION FILTER IN THE ANALYSIS OF THE ISOTOPIC COMPOSITION OF HYDROGEN–DEUTERIUM MIXTURES. V.A.Borgest and A.N.Zaĭdel'.

Optika i Spektrosk., Vol. 5, No. 6, 686-91 (1958). In Russian.

Describes two variants of Wood's interference-polarization filter and their use in the isotopic analysis of hydrogen with less than 0.1% or more than 10% (10-90%) of deuterium. The filter is used to separate out α-lines of H and D. The intensities of the H_α and D_α lines are measured by suitably calibrating the apparatus using hydrogen–deuterium mixtures of known composition. The H_α and D_α lines are excited in a specially constructed water-cooled discharge tube. A.Tybulewicz

535.347

6757. DICHROISM IN ESSENTIALLY PURE AND ACTIVATED CADMIUM SULFIDE SINGLE CRYSTALS. S.J.Czyzak, R.C.Crane and T.M.Bieniewski.

J. Opt. Soc. Amer., Vol. 49, No. 5, 485-8 (May, 1959).

Dichroism was observed in CdS, CdS:Cu, CdS:Mn, CdS:In, and CdS:O single crystals. The activated crystals contained 0.1% of activator except in the case of oxygen activator which is ~1%. Inversion of the crystal sign, i.e. positive to negative, was observed in CdS crystals at 5245 A. In the case of activated crystals, the inversion point was obtained by extrapolation and found to coincide with that of the "pure" CdS crystal. A simplified method for measuring indexes of refraction over a wide range has also been devised.

535.348 : 539.2

COLORATION OF BIOTITES BY α-PARTICLES IN PLEOCHROIC HALOES. II. See Abstr. 6289

535.37 : 539.2

ON COLORATION AND LUMINESCENCE OF NaCl AND NaCl/A UNDER ELECTRON IRRADIATION. See Abstr. 6284

535.37 : 548.

PROPERTIES OF THALLIUM ACTIVATED LUMINOUS ALKALI HALIDES. See Abstr. 6357

535.37

6758. THE ALTERATION OF THE LUMINESCENCE OF MANGANESE-ACTIVATED CADMIUM CHLOROPHOSPHATE BY BISMUTH. H.Ruffler.

Tech. wiss. Abhandl. Osram—Gesell., Vol. 7, 211-18 (1958). In German.

The samples contained 3 atomic percent of Mn, and 5 proportio of Bi up to 0.49 atomic percent. Bi does not affect the emission spectrum under 2537A, but the overall efficiency decreases to 1/5 over the range used, and the temperature dependence of the two emission bands is altered differently by Bi. The afterglow shows a sharp increase with Bi up to 0.068%, and then decreases. At the same concentration there is a maximum Riehl effect (non-linear ratio between excitation and emission), and also the maximum development of the glow curve peaks at 230° and 260°C. Pb and As produce similar effects to Bi on the glow curve. The mechanism o the Bi effects is briefly discussed. S.T.Henderso

535.37

6759. THE EVALUATION OF CONDUCTIVITY GLOW CURVES. K.W.Böer, S.Oberländer and J.Voigt.

Ann. Phys. (Leipzig), Folge 7, Vol. 2, No. 3-4, 130-45 (1958). In German.

Glow curve equations are derived for a model with a single trapping level. Measurements were made with CdS:Cu and CdS:Co having single conductivity glow peaks. The approximate formula o Randall and Wilkins (Abstr. 757-8/1946) gives a good value for the position of trapping levels, even when re-trapping cannot be neglec ted. J.Fran

535.3

6760. INVESTIGATION OF INORGANIC SCINTILLATION PHOSPHORS, WITH SPECIAL REFERENCE TO CAESIUM IODIDE H.Knoepfel, E.Loepfe and P.Stoll.

Helv. phys. Acta, Vol. 30, No. 6, 521-52 (1957). In German.

The scintillation properties of CsI(Tl) are described. For α-particles of 5.3 MeV a decay time τ_0 of 0.55 μsec and a resolvin power Γ of 3.5% were measured; the maximum λ_{max} of the emissi is near 5900 A, and the absolute efficiency ηp of the phosphor is 6.5%. If the melt of CsI pure is overheated in the vacuum and ther crystallized, a very effective scintillation phosphor results withou any addition of an activator; ηp is 9.3%, and λ_{max} = 4100 A. Expe mental results concerning the emission centres of CsI phosphors recorded. The decay time and the intensity as a function of tempe ture for α-particle excitation, the excitation function in the ultraviolet region and the spectral emission for ultraviolet and corpus excitation of CsI probes of different preparation modes were mea ured. There results strong evidence that in CsI(Tl) there are not the Tl-complexes that act as emission centres, but that iodine vacancies play a predominant role. The Tl-ion attracts several iodine ions and forms a Fromherz complex. In this way vacancie the iodine lattice are formed. The emission of the CsI phosphors nfluenced by the Tl-ions, but the same influence can be observed after the incorporation of iodine molecules. The undisturbed centres are formed by crystallization of the overheated melt in the vacuum.

535.371

6761. LUMINESCENCE OF CsI AND NaI. H.Enz and J.Rossel.
Helv. phys. Acta, Vol. 31, No. 1, 25-32 (1958). In French.

Improved measurements of the decay law and of the temperature dependence of the decay time and luminescent yield were made for wo types of scintillation in pure CsI and NaI. The results show that one type is described by a relatively simple model and may be explained, for NaI, as the recombination of degenerated excitons, self-trapped in the crystal lattice. The other type of scintillation, however, is related to permanent defects produced in the crystal by hermal treatment or plastic deformation and is only partially accounted for by the simple general model valid in the first case.

535.371

6762. LIFETIME OF PHOSPHORESCENCE OF SUBSTITUTED NAPHTHALENES. K.Iguchi.
J. chem. Phys., Vol. 30, No. 1, 319-20 (Jan., 1959).

Molecular integrals for the substituted naphthalene ring system are computed, with F, Cl and Br substitution. The lifetime of phosphorescence is obtained and compared with experimental values.
J.Franks

535.371

6763. UNUSUAL TEMPERATURE DEPENDENCE OF FLUORESCENCE OF URANYL IONS EMBEDDED IN ICE.
S.Hayakawa and M.Hirata.
J. chem. Phys., Vol. 30, No. 1, 330 (Jan., 1959).

Emission spectra of uranyl nitrate (UN) and concentrated solutions of UN in water under u.v. excitation at −190°C were similar, but additional bands appeared as the concentration was decreased. The additional bands vanished above −130°C. The fluorescence intensity of pure UN and of concentrated solutions decreased gradually with increasing temperature, broad bands appeared in the intensity curve for dilute solutions.
J.Franks

535.371 : 539.19

6764. SOME EXPERIMENTS RELATED TO THE PROBLEM OF INTERNAL CONVERSION OF EXCITATION ENERGY IN AROMATIC MOLECULES AND CRYSTALS. J.Ferguson.
J. molecular Spectrosc., Vol. 3, No. 2, 177-84 (April, 1959).

The relative quantum efficiencies of fluorescence or phosphorescence as a function of exciting wavelength were determined for a number of aromatic compounds in solution or rigid glasses. Although internal conversion of excitation energy from higher excited states to the lowest state is very efficient it is shown that other nonradiative processes can compete for the excitation energy: predissociation and intersystem crossing. Measurements of the temperature dependence of the fluorescence from crystals of tetracene and 9, 10-dichloroanthracene show that the quenching processes have activation energies of the order of lattice vibration frequencies.

535.371

6765. STIMULATED INFRARED EMISSION FROM Sm CENTERS IN SrS PHOSPHORS. S.P.Keller.
Phys. Rev., Vol. 113, No. 6, 1415-16 (March 15, 1959).

Previous investigations (Abstr. 2985/1958, 3319/1959) of the two phosphor systems SrS: Ce, Sm and SrS: Eu, Sm indicated that two energy levels with the energy gap were associated with the Sm site. Under certain conditions one expected that a transition between these two levels of the same centre would result in an infrared emission. This emission was not seen at room temperature but it was recently observed at 77°K under dynamic conditions of simultaneous irradiation by ultraviolet and visible light. Correlation is made between the observed emission and the simplified band-theory model proposed earlier.

535.371 : 539.21

CHANGES IN TRAPPING LEVELS OF ZINC SULPHIDE PHOSPHORS RESULTING FROM POSITIVE ION BOMBARDMENT. See Abstr. 6287

535.371.07 : 537.362

INFLUENCE OF FIRING CONDITIONS, COMPOSITION, AND SCREENING MEDIA ON THE ZETA POTENTIALS OF ZnS PHOSPHORS AS RELATED TO ADHERENCE TO GLASS SURFACES. See Abstr. 5751

535.372

6766. RADIATIVE RECOMBINATION AT DISLOCATIONS IN GERMANIUM. C.Benoit à la Guillaume.
J. Phys. Chem. Solids, Vol. 8, 150-3, 164-5 (Jan., 1959). In French.

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The spectral distribution of the emission on recombination of excess carriers was measured for an n-type Ge single crystal between 14° and 95°K. A continuous spectrum is obtained between 0.47 and 0.77 eV consisting of a number of superposed bands, the intensity of each of which varies in a different way with current and temperature. Dislocations in Ge give rise to radiative recombination centres; the energy levels introduced by the dislocations are given.
J.Franks

535.372

6767. FLUORESCENT EMISSION ASCRIBABLE TO EXCITON ANNIHILATION IN PURE CdS CRYSTALS.
E.Grillot and M.Bancie-Grillot.
J. Phys. Chem. Solids, Vol. 8, 187-90 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The green emission of pure CdS at < 100°K is variable in band structure and efficiency. Low temperature sublimation of CdS crystals affords a product not fluorescent at 77°K which at 20°K emits 9 lines in the blue, 6 of these being in a hydrogenoid series. At 4°K a more complex polarized line emission develops, with unusual Seeman effects. Absorption spectra of the crystals depend on the method of preparation. The hydrogenoid series is considered due to exciton annihilation in a nearly perfect lattice.
S.T.Henderson

535.376

6768. ON THE SHORT-TIME AFTERGLOW OF PHOSPHORS UNDER SQUARE-WAVE EXCITATION. A.Schleede.
Tech. wiss. Abhandl. Osram-Gesell., Vol. 7, 194-9 (1958). In German.

Phosphors were excited by 4 kV electrons at 20° and -196°C. The decay times (in μ sec) given are for the room and low temperatures, respectively. Examples of non-exponential recombination luminescence are ZnO, 3.7 and 1.3; ZnS, 70 and 50; Zn_2SiO_4 of blue emission, 4.7 and 2.2. Exponential decay is shown by $CaWO_4$, 10 and 17; ZrP_2O_7, 1.7 and a very slow decay in liquid air; Zn_2SiO_4:Mn, 11 000 and 12 000; MgS:Sb, 2.3 and 3.0. The fastest decay found was for $NaCaPO_4.Ce^{3+}$, 0.4 and 0.48 μsec. Decay curves are given.
S.T.Henderson

535.376 : 539.1.07

6769. PLASTIC SCINTILLATORS. I.M.Rozman.
Izv. Akad. Nauk SSSR, Ser. fiz., Vol. 22, No. 1, 36-40 (1958). In Russian. English summary: PB 141041 T-1, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

A survey of their development since 1950. Methods employed for their production by means of polymerization. Investigations of their luminescence in the case of excitation by ionizing radiation. Opinions concerning the problem of the development of a displacement of the excitation-energy from the base-molecules to the molecules of the luminescing addition. Advantages in practice are enumerated and the importance of their further investigation is emphasized.

535.376 : 537.528 : 621.315.615.2

6770. LIGHT EMISSION FROM INSULATING LIQUIDS DUE TO EXCITATION BY D.C. FIELDS NEAR BREAKDOWN. M.Darveniza.
Nature (London), Vol. 183, 743 (March 14, 1959).

Light emission, similar to the characteristic blue fluorescence excited by ultraviolet radiation, has been observed in degassed transformer oil at d.c. fields > 600 kV/cm, and is attributed to traces of polycyclic aromatic compounds. Pure hexane showed no such emission up to 1.1 MV/cm, but in hexane solutions of anthracene and p-terphenyl luminous cathode-anode filaments were observed at 600-950 kV/cm, the emission being characteristic of the fluorescent solute. The light intensity increased exponentially with the field. Removal of the fluorescent impurities from the oil or hexane solutions increased the breakdown strength. The possibility that the emission was due to micro-discharges, rather than excitation of the fluorescent impurities in the liquid phase, was investigated by applying pressure and tension to the liquid, but no variation in light intensity was observed. The experiments indicate that fluorescent solutes may be excited by high d.c. fields in the liquid phase, and the process is associated with those leading to electrical breakdown.
J.B.Birks

535.376 : 548.522

ELECTROLUMINESCENCE OF ZnS ROD CRYSTALS. See Abstr. 6364

535.376

6771. EXCITATION OF LUMINESCENT MATERIALS BY IONIZING RADIATION. H.Kallmann and J.Dresner.

Phys. Rev., Vol. 114, No. 1, 71-9 (April 1, 1959).

The buildup of light emission under irradiation by X-rays and fast electrons was determined for several inorganic phosphors at room temperature and at −70°C. Measurements were performed under excitation by X-rays of 35 and 3.5 keV and by Sr^{90} β-rays. From a knowledge of these rise curves of light emission, the effective volume of phosphor excited by a single ionizing event can be calculated. For the three types of irradiation used, it was found that the effective volumes of these channels of excitation are proportional to the amount of energy transferred to the phosphor by each ionizing particle and that the ratio between the initial and final values of the light emission is almost independent of the mode of excitation. This implies that the excited electrons diffuse out from the path of the ionizing particle until they are stopped by traps. Evaluation of this diffusion process indicates that only a small percentage of all available deep traps are filled within the effective channel volume by one single event and that a nonbimolecular process participates in the initial light emission. In the above cases, the electrostatic field produced by the positively charged core of the channels is too small to interfere with the diffusion of the excited electrons, In the case of irradiation by high-energy α-particles, this field is large enough to inhibit the diffusion process completely. Only a small part of the energy dissipated by the α-particle is expended in filling all the traps in a narrow channel, the rest being available for radiative processes. This channel model thus accounts for the almost instantaneous rise of light emission which is observed under irradiation by α-particles.

535.377

6772. AN UNUSUAL THERMOLUMINESCENCE PHENOMENON. N.Grögler and H.Stauffer.

Helv. phys. Acta, Vol. 32, No. 2, 129-34 (1959). In German.

This phenomenon was observed by measuring the glow-curves of Dickit samples by the flash-heating method. During the first heating, no light emission was observed. But during the cooling process, which lasts about 1 min, a glow-curve appeared, which had one maximum at a temperature of about 40°C. If the sample is heated a second time, a glow-curve may be observed with a maximum at about 200°C. Every repetition of the heating and cooling process shows the same effects, without excitation of the luminescence centres by electromagnetic or corpuscular radiation. Therefore, these thermoluminescence effects are due to thermal excitation. Some preliminary experimental results are described. No explanation of the phenomenon is given.

535.379

6773. INFRARED CHEMILUMINESCENCE FROM THE GASEOUS REACTION ATOMIC H· PLUS O_2. J.K.Cashion and J.C.Polanyi.

J. chem. Phys., Vol. 30, No. 1, 316-17 (Jan., 1959).

The authors have investigated the emission spectra of the hydroperoxy radical (HO_2). Infrared measurements show a principal emission extending from 3400-4000 cm^{-1} which possesses three distinct maxima. There is also a much weaker second emission — which has no distinct maxima — in the 6000-8000 cm^{-1} region.

D.L.Greenaway

535.379

6774. INFRARED CHEMILUMINESCENCE FROM THE GASEOUS REACTION ATOMIC H· PLUS NO; HNO IN EMISSION.

J.K.Cashion and J.C.Polanyi.

J. chem. Phys., Vol. 30, No. 1, 317-18 (Jan., 1959).

Emission bands in the spectral regions 2500-3700 cm^{-1} and 7000-16 500 cm^{-1} have been detected in the reaction of atomic hydrogen with nitric oxide which are attributed to vibrationally and electronically excited states of the (HNO) radical. The positions, relative intensities, and tentative assignments of the observed maxima are tabulated.

D.L.Greenaway

535.39

6775. MEASUREMENT OF OPTICAL CLARITY BY LOW-ANGLE LIGHT SCATTERING. F.W.Billmeyer, Jr.

J. Opt. Soc. Amer., Vol. 49, No. 4, 368-71 (April, 1959).

Light scattering from small particles in liquids and transparent solids may lead to a loss in optical clarity. If the scattering particles are in the micron size range, the scattering is confined to small angles with respect to the direction of the incident light. The resulting phenomenon does not correlate with integrating sphere haze. Examples of this type of optical defect are occasionally observed in plastic sheet or film samples. A photometer is described for the quantitative measurement of this type of light scattering. It measures scattered light photoelectrically at a 10° angle with an angular resolution of 1°. It is suitable for plant control applications as well as research and development. Visual estimates of optical clarity correlate well with instrumental low-angle light scattering.

535.39

6776. SIMPLE PULSED ULTRAVIOLET LIGHT SOURCE. R.F.Weeks.

J. Opt. Soc. Amer., Vol. 49, No. 5, 429-33 (May, 1959).

A pulsing circuit to permit the use of a conventional low-pressure "Nester" hydrogen arc as an ultraviolet stimulating source for luminescence studies is described. The pulse duration may be varied from about 5 msec to 30 μsec with a repetition rate of 60 per second. There is no perceptible variation of the light form from pulse to pulse. The rise time of the pulses is 20 μsec and the fall time, 0.3 μsec. The pulsing circuit is assembled from conventional electronic components and contains no critical high-frequency circuits. The inherent spectral range and reliability of operation of the Nester lamp are maintained and the unit may be easily switched to d.c. operation. The use of this source in kinetics measurements is discussed briefly.

535.393 : 537.312.5

6777. OPTICAL AND PHOTOELECTRIC PROPERTIES OF THIN METALLIC FILMS IN THE VACUUM ULTRAVIOLET.

W.C.Walker, O.P.Rustgi and G.L.Weissler.

J. Opt. Soc. Amer., Vol. 49, No. 5, 471-5 (May, 1959).

Measurements were made on evaporated thin films of Al, Sn, In, Bi, Au, Ag, and Cd in order to correlate optical transmission, reflection, and photoemission in the far ultraviolet. Thin unbacked films prepared outside the spectrograph and glass-backed films prepared inside the spectrograph were used. The frequency at which the films change from a reflecting medium to a transmitting medium was compared with the plasma frequency predicted by Bohm and Pines (Abstr. 5379/1951, 2688/1952, 1278/1954) and also with electron energy eigen losses in metals observed by Marton et al. Some new absorption transitions were observed and related to X-ray absorption edges. A qualitative correlation between the photoelectric yields and corresponding optical properties was attempted.

535.39

6778. REFLECTING COATINGS FOR THE EXTREME ULTRAVIOLET. G.Hass and R.Tousey.

J. Opt. Soc. Amer., Vol. 49, No. 6, 593-602 (June, 1959).

The conditions for preparing evaporated Al films of highest reflectance for mirrors and gratings to be used in the vacuum ultraviolet are summarized, and an account is given of aging studies. The preparation of bloom-free, one-micron thick coatings for grating blanks is described, and the effect of thin overcoatings on th efficiency of ruled gratings is discussed. Data are presented on the reflectance and aging of other film materials, such as Pt, ZnS, and Al_2O_3, which are more suitable for use at wavelengths below 1200 A A discussion is given of the preparation and the reflecting propertie of various multilayer film combinations suitable for reducing the reflectance of mirrors and gratings in the visible and the near ultr voilet while at the same time preserving a high reflectance in the extreme ultraviolet. A 250 A thick layer of MgF_2 evaporated onto a Al coating immediately after its deposition was found both to raise the reflectance to about 80% at wavelengths down to 1200 A, and to retard aging.

535.39

6779. OPTICAL PROPERTIES OF NICKEL AND TUNGSTEN AND THEIR INTERPRETATION ACCORDING TO DRUDE'S FORMULA. S.Roberts.

Phys. Rev., Vol. 114, No. 1, 104-15 (April 1, 1959).

New optical data are reported for nickel at 88°, 298°, and 473°K and for tungsten at 298°, 1100°, and 1600°K in the wavelength range 0.365 to 2.65 μ. These data are shown to depend on waveleng in a way which is in good quantitative agreement with a formula initially proposed by Drude. By attributing different terms in Drude's equation to the motion of different classes of free and bour electrons, one may conclude that several classes of each are prese in both metals. Each class of free electrons accounts for a portion of the d.c. conductivity and has its own characteristic relaxation time or wavelength. From this analysis it appears that most of the d.c. conductivity may be attributed to one class of free electrons, although optical properties are strongly influenced by other classes as well. In both metals the characteristic wavelength λ_{r_1} of the first class of free electrons proves to be proportional to the corresponding conductivity σ_1 at different temperatures. In nickel the constant ratio σ_1/λ_{r_1} accounts for the low temperature coefficient of optical properties throughout the visible and near infrared range. In tungsten this constant ratio contributes to the existence of the x-point or cross-over wavelength in the spectral emissivity. It is shown that the anomalous skin effect may not be a significant factor in the measured optical properties of a metal like nickel in the range of wavelength where these properties have only a small temperature coefficient.

535.399

6780. ON THE PROBLEM OF DETERMINATION OF OPTICAL CHARACTERISTICS FROM REFLECTION. L.D.Kislovskiĭ.
Optika i Spektrosk., Vol. 5, No. 1, 66-70 (1958). In Russian.
English summary: 141047T-6, obtainable from Office of Technical Services, U.S.Dept. of Commerce, Washington, D.C., U.S.A.

A universal graphical method for determination of optical constants from two photometric reflection measurements is described. This method makes it possible to find the values of the refractive index (n), the absorption coefficient (k), $\epsilon_1 = n^2 - k^2$ and $\epsilon_2 = 2nk$, given the values of the ratio of the reflected to the incident amplitudes (ρ) and the phase-shift on reflection (δ). The procedure can be generalized to oblique angles of incidence. Using a photographic enlarger the procedure can be speeded up by projecting a grid of (ρ,δ) on a required scale on to the plane (n,k). The method is explained in detail and examples of appropriate graphs are given.

535.41

6781. INTERFERENCE AT GREAT RETARDATIONS OBTAINED WITH A CALCIUM ATOMIC BEAM SOURCE.
K.W.Meissner and V.Kaufman.
J. Opt. Soc. Amer., Vol. 49, No. 5, 434-8 (May, 1959).

By employing a calcium atomic beam source in emission and by using a beam of high collimation very clear Fabry—Perot patterns of the resonance line of calcium, λ4226 A, were obtained with retardations of 60, 78, 94, 108, 120, and 130 cm. The corresponding order numbers are about 1.42, 1.85, 2.22, 2.56, 2.84, and 3.08 million and greatly surpass those obtainable with the best conventional cooled source available at present. The good definition of the fringes obtained with the retardation of 130 cm suggests that the limit of interference is considerably higher.

535.411

6782. COMPARATOR WITH PHOTOELECTRIC DETECTION FOR SETTING ON BROAD INTERFERENCE FRINGES WITH PRECISION. J.M.Bennett and W.F.Koehler.
J. Opt. Soc. Amer., Vol. 49, No. 5, 466-7 (May, 1959).

A comparator with a photoelectric detection system is described. Experimental data are reported to demonstrate that the same setting precision of ±0.2 micron is associated with the measured position of a normally exposed two-beam interference fringe, an overexposed two-beam interference fringe, a multiple-beam interference fringe, and a spectral line. The corresponding setting precisions obtained by the usual visual techniques are +6.2 ±3.0, ±1.1, and ±0.6 microns, respectively.

535.411 : 535.14

PHOTON COINCIDENCES AND HANBURY BROWN'S INTERFEROMETER. See Abstr. 6669

535.417

6783. EFFECT OF SURFACE ROUGHNESS ON THE PHASE CHANGE AT REFLECTION IN INTERFEROMETERS.
B.S.Thornton.
J. Opt. Soc. Amer., Vol. 49, No. 5, 476-9 (May, 1959).

The effect of the phase change of light due to surface roughness on the precision measurement of length by interferometry is an important practical problem upon which only little work seems to have been done. This paper investigates the effect from a theoretical and experimental standpoint and shows that the phase loss due to surface roughness is a function of wavelength as well as a function of the amplitude and waveform of the roughness.

535,417 : 531.715

6784. INTERFEROMETER FOR LARGE SURFACES.
J.B.Saunders and F.L.Gross.
J. Res. Nat. Bur. Stand., Vol. 62, No. 4, 137-9 (April, 1959).

An interferometer is described that permits the testing of large areas, such as layout plates. The extension to large areas is obtained by causing a collimated beam of light to reflect from the specimen at a large angle of incidence. The resultant fringe pattern is a contour map of the surface relative to an arbitrarily chosen plane and the contour interval is a function of wavelength and angle of incidence.

535.417

6785. AN INTERFERENCE PHOTOMETER FOR THE MEASUREMENT OF AMPLITUDE DISTRIBUTIONS IN DIFFRACTION PATTERNS. M.De.
Optica Acta, Vol. 4, No. 2, 45-53 (June, 1957).

An interference photometer is described which measures the distribution of intensity and phase in the image of a point source. It is a simple modification of the Mach—Zehnder type of interferometer, and is essentially an analogue computor for the evaluation of diffraction integrals. The photometric advantage of this method is discussed in relation to the method of direct scanning. This interference method also gives the distribution of phase directly — a measurement which was not previously possible. The accuracy of the method is found to be greater than that to be expected from direct scanning methods. The effect of a finite size of source has also been studied in respect of the visibility of fringes and its influence on the results obtained.

535.417 : 531.715

6786. CORRECTIONS OF INTERFERENCE THICKNESS MEASUREMENTS OF THIN FILMS ON ACCOUNT OF BOUNDARY REFLECTIONS. P.J.Lindberg.
Optica Acta, Vol. 4, No. 2, 59-68 (June, 1957).

Multiple-beam interferences show a remarkable effect owing to boundary reflections when a transparent film is interposed between the interferometer flats. Similar conditions occur in all interferometric thickness measurements of transparent films. The phase-shift so caused is calculated and represented in diagrams with rolling circles. Measurements were made with multiple-beam interference on zinc sulphide films deposited on silver, and the results agreed satisfactorily with the calculations. If the boundary reflections are neglected in the case of multiple-beam interference, the error in the determination of the film thickness is at most about $\lambda/2\pi$, even if the difference in refractive index is small. The consequences of this are considered for the interferometric measurement of biological specimens.

535.417 : 531.715

6787. THE INTERFEROMETRIC MEASUREMENT OF METAL OXIDE FILMS. J.C.Kelly.
Optica Acta, Vol. 5, No. 3-4, 75-8 (Sept.-Dec., 1958).

A method is described for investigating oxide films in situ on the metal surface. The method yields the surface finish of the inside and outside surfaces of a metal oxide film, its volume ratio, its thickness and the location of the original surface with respect to the two oxide surfaces. All this information is contained in a single photograph provided the refractive index of the oxide is known. Some results for anodic oxide films on aluminium are given.

535.417 : 535.345

6788. ON THE LIMITING BAND WIDTH OF INTERFERENCE FILTERS. P.Giacomo, P.W.Baumeister and F.A.Jenkins.
Proc. Phys. Soc., Vol. 73, Pt 3, 480-9 (March, 1959).

The effects of variations of the thickness of the individual layers of an interference filter made with dielectric multilayers are examined, with respect both to the displacement of the pass band and to its width as affected by random fluctuations in these thicknesses. It is shown that the use of special multilayer stacks having a large dispersion of the phase change on reflection can yield a much greater resolution only in the case of perfectly uniform films. The insentivity of the pass band to variations of the spacer layer is compensated by a correspondingly large sensitivity to variations of the layers constituting the "mirrors". It is also shown that the effect of random thickness variations is a minimum when the sensitivities of all layers are proportional to their thicknesses. Sample calculations and experimental illustrations are given.

535.417 : 531.715

6789. A NEW INTERFEROMETER WITH THREE WAVES.
J.J.Hunzinger.
Rev. Opt., Vol. 36, No. 6, 285-91 (June, 1957). In French.

A new type of interferometer is described using three interfering waves. This is suitable for the measurement of end-standard gauges. There are certain advantages in the system which are discussed. An arrangement for mounting the mirrors is described. In effect, the system can be considered as a compound Michelson interferometer in which two dividing mirrors are used behind each other. The intensity distribution in the fringe system is discussed.

S.Tolansky

535.417 : 532.64

STUDY OF THE ANGLES OF CONTACT OF LIQUID SURFACES WITH SOLIDS BY INTERFERENCE IN POLARIZED LIGHT. See Abstr. 6586

535.42

6790. FAR-FIELD DIFFRACTION AND BORESIGHT ERROR PROPERTIES OF A TWO-DIMENSIONAL WEDGE.

A.I.Mahan, C.V.Bitterli and C.G.Wein.

J. Opt. Soc. Amer., Vol. 49, No. 6, 535-56 (June, 1959).

An optical diffraction theory is developed which can be used to predict the forms of the far-field diffraction patterns and boresight error effects of a two-dimensional wedge made from two semi-infinite plane parallel plates. The solution is strictly an optical one, since the wavelength is assumed to be small compared with the dimensions of the rectangular diffracting aperture, and also because the rectangular diffracting aperture is assumed to lie in the "near-field" of the wedge. In tracing the directly transmitted and all the multiply internally reflected wave fronts through the wedge to the plane of the diffracting aperture, amplitude losses due to reflection and absorption, phase changes due to increases in optical path, and changes in width of the various wave fronts are all evaluated in the plane of the diffracting aperture. When once the amplitude and phase distributions are known in the plane of the diffracting aperture, the Kirchhoff integrals are readily written and integrated. The UNIVAC computer can then be used to evaluate the forms of the far-field diffraction patterns characteristic of the wedge and diffracting aperture. These far-field diffraction patterns are in general non-symmetric and have forms which are functions of the plane of polarization of the incident electric vector and nine other variables. For arbitrary values of the variables, the forms of these far-field diffraction patterns cannot be understood in terms of conventional plane parallel plate theory, but in certain limiting cases plane parallel plate theory is useful. Boresight error curves were evaluated as functions of many of the variables, and the magnitudes and signs of these errors are in agreement with the previously computed diffraction patterns. "Qualitative" checks on the theory were also made by comparing the calculated forms of the far-field diffraction patterns for a particular glass wedge with those which were photographed experimentally. All of the calculated changes in form of these far-field diffraction patterns were observed experimentally, and there is good reason to believe that a quantitative check might also be possible under more favourable experimental conditions.

535.421

6791. SECONDARY INTERFERENCE IN THE FRESNEL ZONE OF GRATINGS. E.A.Hiedemann and M.A.Breazeale.

J. Opt. Soc. Amer., Vol. 49, No. 4, 372-5 (April, 1959).

The Fresnel zone of optical gratings — the region behind the grating where secondary interference between the light coming through the different openings produces real images of the grating — can be understood by comparison with other types of wave phenomena. In the Fresnel zone of light diffracted by an optical grating, different types of amplitude modulation of the wave front are observable. Gratings of stationary ultrasonic waves, being phase gratings to the light passing through them, produce similar, though not identical Fresnel patterns. Between the planes in which the secondary interference patterns are true images of the gratings, the modulation changes from amplitude to phase modulation. This change can be demonstrated by an ultrasonic wave analogue. Patterns formed by the diffraction of ultrasonic waves by an amplitude grating are given. Similar patterns in surface waves are given for both the phase grating and the amplitude grating analogue.

535.421

6792. THEORY OF THE CONCAVE GRATING. I. T.Namioka.

J. Opt. Soc. Amer., Vol. 49, No. 5, 446-60 (May, 1959).

The theory of the concave grating was examined in considerable detail by methods of geometrical optics. The results derived by means of geometrical optics were checked by comparing them with those based on physical optics in special cases. The conditions for image formation and aberrations in the image may be expressed by equations somewhat different from those given by Beutler (Abstr. 2949/1945) which are shown to be in error. The astigmatism and other aberrations are treated with respect to finite length of slit illumination, finite grating size and deviations of the optical components from the Rowland plane but still lying on the Rowland cylinder. Within certain limitations, it is shown that the aberrations present in an off-plane Eagle mounting may be corrected by a very small rotation of the slit in a plane perpendicular to the optic axis. The optimum width of the grating, instrumental line half-width, and resolving power of the grating are also discussed. Finally, the Beutler treatment of the concave grating is examined in detail and the important errors are pointed out.

535.421

6793. THEORY OF THE CONCAVE GRATING. II. APPLICATION OF THE THEORY TO THE OFF-PLANE EAGLE MOUNTING IN A VACUUM SPECTROGRAPH. T.Namioka.

J. Opt. Soc. Amer., Vol. 49, No. 5, 460-5 (May, 1959).

A recent treatment of concave grating theory (see preceding abstr.) is applied to an off-plane Eagle vacuum spectrograph, especially to that employing a grating of 21-foot radius and 30 000 lines/in. Three tables and two graphs summarize the numerical calculations on the following factors: (1) change in wavelength from that calculated by the ordinary grating equation; (2) angle of slit rotation with respect to the grating rulings as a function of the angle of incidence; (3) optimum grating size as a function of the angle of incidence and spectral order; (4) resolving power in the 1250 to 2000 A region as affected by emulsion grain size, length of slit illumination, spectral order, and slit width. The calculations are found to be in reasonable agreement with experiment.

535.43

6794. DEPOLARIZED COMPONENTS OF LIGHT SCATTERED BY GLASSES. I. MEASUREMENTS ON TWELVE OPTICAL GLASSES. M.Goldstein.

J. appl. Phys., Vol. 30, No. 4(1), 493-500 (April, 1959).

Measurements were made of Rayleigh's ratio and the depolarization ratios ρ_v and ρ_h on twelve optical glasses. Within an estimated error of ±5%, the ratio ρ_h equals unity in eleven of them, in apparent contradiction to the work of other investigators. It is concluded that light scattering does not distinguish a glass from a liquid.

535.43

6795. DEPOLARIZED COMPONENTS OF LIGHT SCATTERED BY GLASSES. II. INFLUENCE OF NONANNEALABLE STRAINS ON THE SCATTERING. M.Goldstein.

J. appl. Phys., Vol. 30, No. 4(1), 501-6 (April, 1959).

Light scattering measurements on twelve optical glasses revealed that most have depolarization ratios $\rho_h = 1$ within experimental error. A theory postulating the existence of a type of nonannealable strain in glasses, proposed by Mueller to account for some observations giving ρ_h less than one, is recast in a form enabling an estimate of the magnitude of the effect to be made. It is found that in most cases the effect predicted is within present experimental error. If, however, an appreciable part of the glass consisted of domains of some of the crystalline forms of silica, ρ_h could be reduced significantly below one by this type of strain. The fact that ρ_h is unity in vitreous silica is an argument against the existence of such domains.

535.43 : 539.21

6796. THE RESIDUAL SCATTERING OF POLISHED SURFACES AND GRATINGS. A.Maréchal.

Optica Acta, Vol. 5, No. 3-4, 70-4 (Sept.-Dec., 1958). In French.

The quality of polish of an optical surface can be characterized by the depth and extent of its irregularities. A study of the scatteri of light can give useful information about this: one can express (1) the total scattered energy as a function of the mean square of the irregularities; and (2) the law of angular distribution of energy as a function of the Fourier transform of the auto-correlation function of the irregularities. The case of random errors in the position of grating lines is also treated. The present paper is a theoretical treatment, and experimental results in verification are not given.

535.43.0

6797. ABSOLUTE LIGHT-SCATTERING PHOTOMETER. I. DESIGN AND OPERATION. D.McIntyre and G.C.Doderer.

J. Res. Nat. Bur. Stand., Vol. 62, 153-9 (April, 1959).

Designed and built for determining the absolute scattering fro polymer solutions. The instrument is also capable of performing a a research instrument for making measurements at very low and very high angles, and at very low and very high intensities of scattered light. The instrument scans the angular scattering either manually or automatically while measuring continuously the ratio of the scattered light to the incident light.

535.434

6798. THEORETICAL INVESTIGATIONS ON THE LIGHT SCATTERING OF COLLOIDAL SPHERES. VI. BACKWARD SCATTERING. M.Nakagaki and W.Heller.
J. chem. Phys., Vol. 30, No. 3, 783-6 (March, 1959).

For Pt V, see Abstr. 5595 (1959). Light scattering of non-absorbing colloidal spheres in the direction towards the incident primary beam (backward direction) is investigated on the basis of the Mie theory. The parameters considered are: $\alpha = 0.2(0.2)\ 15.2$ and $m = 1.20$. The data obtained are compared with those derived from the Rayleigh—Gans—Debye equation. A simple equation is derived by means of which the α values at maximal and minimal scattering can be calculated in satisfactory approximation. Data of the "extreme dissymmetry" — i_0/i_{180} — are given.

535.434 : 771.534

THE INFLUENCE OF SCATTERING WITHIN PHOTOGRAPHIC EMULSIONS ON RESOLVING POWER. See Abstr. 6433

535.514

6799. AN ACHROMATIC HALF-WAVE PLATE.
M.Françon and D.Vázquez.
An. Real Soc. Espan. Fis. Quim., Vol. 55(A), No. 1-2, 47-60 (Jan.-Feb., 1959). In Spanish.

The construction and theory of a half-wave plate is given. The system is made to act as a half-wave plate for a number of wavelengths throughout the spectrum, so that it may be used with white light. The method of use and typical results are shown.

R.W.Fish

535.514.2

6800. REFLECTION OF INFRARED RADIATION FROM A GERMANIUM—MERCURY INTERFACE. N.J.Harrick.
J. Opt. Soc. Amer., Vol. 49, No. 4, 376-9 (April, 1959).

The reflection coefficients for perpendicular and parallel polarization of a germanium—mercury interface were measured as a function of angle of incidence at a wavelength of three microns. There is in general good agreement with theory, although at the principal angle, the parallel component of polarization is absorbed more strongly than indicated by theory.

535.514.2

6801. INFRARED POLARIZER. N.J.Harrick.
J. Opt. Soc. Amer., Vol. 49, No. 4, 379-80 (April, 1959).

An infrared polarizer is described utilizing the difference in the reflection coefficients for the parallel and perpendicular components of polarization at the principal angle for a germanium—mercury interface (see preceding abstract). Because of the high degree of polarization observed, two reflections are considered sufficient for most purposes. Such a polarizer should be useful for the wavelength range of 2μ to 0.2 mm; this range could be varied somewhat by choosing other dielectrics.

535.515

6802. DOUBLE-REFRACTION INTERFERENCE COLOURS OF VERY THIN PLATES. S.Rösch.
Optica Acta, Vol. 6, No. 2, 186-95 (April, 1959). In German.

A systematic method of specifying interference colours is ormulated. Detailed consideration is given to the colours produced by thin layers (at the beginning of the 1st order) of doubly refracting media between polarizers with angles of inclination varying from 0° to 90°. Practical applications of the results are discussed. The colours for $d = 0$ in doubly refracting dispersive materials Brewster—Herschel colours) are calculated.

535.54

6803. ACHROMATIC COMBINATIONS OF HALF-WAVE PLATES.
C.J.Koester.
. Opt. Soc. Amer., Vol. 49, No. 4, 405-9 (April, 1959).

The plane of polarization of two or more wavelengths can be rotated by a predetermined amount through the use of two or more dentical half-wave plates in series, the axes of which are oriented at predetermined angles with respect to the incident plane of polarization. For two wavelengths a rotation of 90° may be ccomplished by the use of two plates with their slow axes at angles of $22.5^\circ + \delta$ and $67.5^\circ - \delta$, respectively. For three wavelengths 90° rotation is obtained by using three plates at angles of $11.25^\circ + \delta$ 5° and $78.75^\circ - \delta$ respectively. The quantity δ is a small angle sually less than 1° which determines the spectral range of achromatization. Identical half-wave plates are easily obtained by cutting a single splitting of mica or a plane parallel sheet of other birefringent material. The wavelength for which the plates have half-wave retardation is not critical. Rather than having a smaller angular aperture than the single half-wave plate, the three-element achromatic rotator has a larger angular aperture. The use of the stereographic projection of the Poincaré sphere for graphical solution of polarized light problems is discussed briefly.

535.55 : 531.25

6804. PHOTOELASTIC CONSTANTS OF VITREOUS SILICA AND ITS ELASTIC COEFFICIENT OF REFRACTIVE INDEX.
W.Primak and D.Post.
J. appl. Phys., Vol. 30, No. 5, 779-88 (May, 1959).

The photoelastic constants and their dispersion for visible light were determined for two samples of vitreous silica, Corning and Herasil No. 1. The results for the mercury green line, $546\ \mathrm{m}\mu$, are quoted here. The photoelastic constants were $4.22 \times 10^{-13}\ (\mathrm{d/cm^2})^{-1}$ (ordinary ray) and $3.56 \times 10^{-13}\ (\mathrm{d/cm^2})^{-1}$ (extraordinary ray). From the ratio of Poisson's ratio to Young's modulus $0.216 \times 10^{-12}\ (\mathrm{d/cm^2})^{-1}$ and Young's modulus $0.76 \times 10^{12}\ (\mathrm{d/cm^2})$, which were also determined, there were calculated the pressure coefficient of refractive index $0.909 \times 10^{-12}\ (\mathrm{d/cm^2})^{-1}$ and the elasticity volume coefficient of refractive index $V\ dN/dV = 0.34$. Comparison of these results with those reported for other glasses indicates that the oxygen ions of vitreous silica are more deformable than the oxygen ions of other siliceous glasses. In vitreous silica about $\frac{1}{3}$ of the volume change accompanying an elastic dilatation arises from the dilatation of the oxygen ions. A comparison is also made with the results reported for corresponding thermally induced effects. It indicates that (a) during a thermal dilatation of a siliceous glass, the oxygen ion undergoes a dilatation which in the case of most siliceous glasses causes an equivalent dilatation of the body, but which in the case of vitreous occurs internally instead, and (b) in crystal quartz no appreciable dilatation of the oxygen ion occurs during a thermal dilatation. The thermal dilatation of the oxygen ion in the glasses would thus seem related to its strained bond configuration.

535.566.2

6805. OPTICAL ACTIVITY IN ABSORBING MEDIA.
W.Moffitt and A.Moscowitz.
J. chem. Phys., Vol. 30, No. 3, 648-60 (March, 1959).

Certain dispersion formulae relating the ellipticity and molecular rotation of optically active solutions, are derived. These are analogous to the Kramers—Kronig transform relations between the absorption and refractive indices. Some discussion is offered of the factors influencing the respective shapes of absorption and ellipticity curves.

535.568

6806. OPTIMUM HALF-SHADE ANGLE IN POLARIZING INSTRUMENTS. S.Inoué and C.J.Koester.
J. Opt. Soc. Amer., Vol. 49, No. 6, 556-9 (June, 1959).

For visual instruments employing polarized light, half-shade devices have long been used to increase the precision of analyser settings. Also when an object of small birefringence is to be detected against a uniform background a bias retardation has been used to increase the contrast. Assuming that Weber's law is valid and that the polarization of the instrument is not perfect, optimum values are calculated for the half-shade angle and the bias retardation. In each case the sensitivity is shown to increase roughly as the square root of the extinction factor, the extinction factor (E) being defined as the ratio of the maximum to the minimum flux transmitted by the analyser. For an interference microscope with $E = 35$ the optimum half-shade angle is 19.2°. For a polarizing microscope with $E = 10^4$ the optimum half-shade angle and bias retardation are each 1.1°.

535.568

6807. HALF-SHADE EYEPIECES FOR THE AO BAKER INTERFERENCE MICROSCOPE. C.J.Koester.
J. Opt. Soc. Amer., Vol. 49, No. 6, 560-2 (June, 1959).

In order to increase the precision of visual settings with the class of instruments employing the Sénarmont compensator, two types of half-shade eyepieces were utilized. The first is the biquartz, placed between the quarter-wave plate and analyser, which rotates the plane of polarization by a fixed amount in opposite directions on the two sides of the field. The second consists of a single thin plate of birefringent material such as quartz placed before the quarter-wave plate and arranged to cover half of the field. The dividing line is made to appear very narrow by employing the principle used in the Lippich prism, namely, that if both sides of the edge are illuminated by the full cone of rays the edge will tend to disappear. The theory of the optimum half-shade angle (see preceding abstract) was applied to determine the thickness of the plate in each type of eyepiece.

535.568.1

6808. THE APPLICATION OF MAGNETIC ROTARY POWER IN PHOTOELECTRIC POLARIMETERS. H.Wenking.
Z. InstrumKde, Vol. 66, No. 1, 1-5 (Jan., 1958). In German.

Two polarimeter systems, one with an auxiliary Wollaston prism, using the Faraday effect are described and theoretical limits of sensitivity estimated. An automatic instrument based on one of these and using a servomotor has been built and gives an accuracy of 0.005°. H.Mykura

535.61.08

6809. PHOTOELECTRIC COMPARATOR FOR WAVELENGTH AND INTENSITY MEASUREMENTS OF SPECTRA. D.W.Steinhaus.
J. Opt. Soc. Amer., Vol. 49, No. 5, 468-70 (May, 1959).

A photoelectric comparator is described that can be used for making wavelength measurements, intensity measurements, and observations of the shapes of spectral lines. The instrument is similar to one described by Tomkins and Fred (Abstr. 8622/1951) with improvements in the optics.

535.64

6810. PROPAGATION OF ERRORS IN COLORIMETRIC TRANSFORMATIONS. G.Wyszecki.
J. Opt. Soc. Amer., Vol. 49, No. 4, 389-93 (April, 1959).

A common colorimetric transformation is a homogeneous linear transformation of tristimulus values from one primary system to another. The transformation coefficients are obtained by spectrophotometry and/or visual colour matching and consequently are subject to certain errors. These errors, together with those associated with the given tristimulus values, propagate into the tristimulus values to be computed by means of the transformation equations. The theory of the propagation of such errors is outlined and illustrated by an example.

535.64

6811. SOME MULTIVARIATE STATISTICAL TECHNIQUES USED IN COLOR MATCHING DATA. J.E.Jackson.
J. Opt. Soc. Amer., Vol. 49, No. 6, 585-92 (June, 1959).

In colour matching studies, statistical tests of significance should not be made on each variable separately since these variables are related and, in general, correlated. Instead, one test should be made for all variables simultaneously. Multivariate generalizations are given for the basic significance tests and are illustrated by examples from actual colour matching studies.

535.64

6812. RELATION BETWEEN THE DISTRIBUTION FUNCTIONS AND THE LUMINOUS EFFICIENCY FUNCTION. F.Blottiau.
Rev. Opt., Vol. 36, No. 5, 235-40 (May, 1957). In French.

Recently it has been suggested that the luminous efficiency of radiation may not be a linear combination of the distribution functions. The author suggests that this may be due to differences between the states of adaptation under which the various functions have been determined and he describes a procedure in which all the necessary comparisons except two are made under identical conditions as regards adaptation, including colour. The conditions for these two could probably be chosen so that the resulting changes of adaptation would have a negligible effect on the functions to be determined. The paper is entirely theoretical. J.W.T.Walsh

535.642

6813. NOTES ON THE NICKERSON–JUDD–WYSZECKI CHROMATIC VALUE TRANSFORMATION. C.J.Bartleson.
J. Opt. Soc. Amer., Vol. 49, No. 5, 489-90 (May, 1959).

The use of Nickerson, Judd and Wyszecki's average loci [Farbe, Vol. 4, 285 (1955)] leads to discrepancies in some cases involving near neutral colours. Suggestions for eliminating them are made. R.A.Weale

535.65

6814. COLOR STANDARDS IN COMMERCE AND INDUSTRY. W.D.Wright.
J. Opt. Soc. Amer., Vol. 49, No. 4, 384-8 (April, 1959).

The use of master colour samples is widespread in industry as a means of colour control and colour standardization. The precision to which the standards have to be maintained varies with the industry, but in the case, for example, of automobiles, a very high consistency of colour matching is demanded. Matches are most frequently judged by eye and colour measuring techniques often find little favour. The extent to which physical instrumentation can and should replace visual inspection is debatable, but if analogy with the measurement of length or light is legitimate, then it would seem desirable to provide sets of permanent reference standards covering a wide range of colours and specified to the highest possible accuracy.

535.7

PHYSIOLOGICAL OPTICS. VISION. See also the Section entitled "BIOPHYSICS. PHYSIOLOGICAL PHYSICS".

535.81 : 535.327

6815. CERTAIN ASPECTS OF THERMAL TREATMENT AND THE STABILIZATION OF THE PROPERTIES OF GLASS. I-II. L.Prod'homme.
Rev. Opt., Vol. 36, No. 7, 309-42 (July); No. 8-9, 391-422 (Aug.-Sept., 1957). In French.

The variation of refractive index with temperature is measured for a number of glasses. It is found that the variations correspond to simple changes in specific volume and specific refraction. The latter is shown to vary in a similar manner for all the glasses and to depend upon the viscosity. Pt II studies the effect of various heat treatments upon the stabilization of a borosilicate glass. The viscosity is shown to control the rate of stabilization. Both parts contain the results of many measurements of optical and other properties of a number of common optical glasses. 70 refs. R.W.Fish

535.81

6816. TESTS ON VARIOUS MATERIALS FOR SUITABILITY AS OPTICAL CEMENTS. II. Y.Besse and J.Demarcq.
Rev. Opt., Vol. 36, No. 10, 476-83 (Oct., 1957). In French.

For previous work see Abstr. 3663 (1956). Three synthetic resins were subjected to temperature, humidity, ultraviolet light, mechanical shock tests, etc. New tests were also used: resistance to salt spray, water, and extreme weather conditions. The results are given in tabular form, in comparison with the cements previously tested. R.W.Fish

535.822 : 531.715.2

MEASUREMENT OF SUBMICRON CIRCULAR APERTURES BY SCANNING MICROSCOPY. See Abstr. 6566

535.826.3

6817. THE MODERN ULTRA-MICROTOME. K.John.
Z. InstrumKde, Vol. 66, No. 1, 5-9 (Jan., 1958). In German.

A survey of microtomes giving cuts below 0.1 μ. H.Mykura

535.832

6818. THE GENERATION OF TORIC SURFACES IN THE OPTICS OF SPECTACLE-MAKING. A.Demuynck.
Optica Acta, Vol. 4, No. 2, 54-8 (June, 1957). In French.

Toric surfaces of the 4th degree used in spectacles can, from the point of view of production, be divided into two forms, "wheel" and "barrel". Geometrical considerations show that the "wheel" type, which is the more commonly used, can only be produced with deformations over a large central area, whereas the "barrel" form can be accurately made. Geometric considerations are discussed for a generally applicable method of producing individual toric surfaces, either convex or concave, by a circular diamond tool. It is shown that the meridian section of the torus produces the form of a meniscus with a rounded edge. Procedures are given for the concave part of the meniscus. It is shown that this concave surface has two sharp points of inflection producing serious deformations in surfaces produced, while the convex part of the meridian section is very regular over all its length and departs little from a circular form. The use of the convex arc always requires a greater clearance of the diamond lap.

535.87

6819. FURTHER ANALYSIS OF THE "LOWER" TEST FOR HIGH-SPEED PARABOLIC MIRRORS. P.R.Yoder, Jr.
J. Opt. Soc. Amer., Vol. 49, No. 5, 439-40 (May, 1959).

The analysis presented in a previous paper (Abstr. 1855/1948). on the Lower test is extended to show that the parabolic correction existing on a mirror figured to this test is a function only of observation distance and not of mirror relative aperture. Graphs are presented to show this relationship. It is suggested by the author that the Lower test may be of value in rough figuring of certain elliptical mirrors since, to third-order approximation, an undercorrected parabola is identical to an ellipse.

535.89

320. RADIATION OF THE HUGGINS—BOL, TYPE A, HIGH-RESSURE MERCURY LAMP. H.A.Stahl.

. Opt. Soc. Amer., Vol. 49, No. 4, 381-4 (April, 1959).

The light output of the Huggins—Bol, type A, high-pressure ercury arc discharge was measured. It was correlated to Baum nd Dunkelman's earlier comparisons (Abstr. 1788/1951) of the enon arc to other ultraviolet sources including the General Electric H-6 mercury lamp. It was found that the Huggins lamp is, at full oad, about 1.5-1.8 times brighter than the AH-6 depending on wave-ength. Self-reversal of radiation in the vicinity of the mercury re-onance line is markedly decreased as compared with the AH-6.

HEAT

536.2

321. ON THE HEAT TRANSFER COEFFICIENTS OF CYLIND-ICAL BODIES. III. T.Tsubouchi and S.Sato.

ep. Inst. High Speed Mech., Tohoku Univ., No. 89, 135-48 (1958).

Details are given of the results of measurements of the heat ransfer coefficients of the vertical ends, and of the curved surface, f a horizontal circular cylinder subject to free convection in the ange $10^5 < Gr < 10^8$. The apparatus was similar to that of ibid. o. 63 (1957). S.Weintroub

536.2 : 532.517.2

822. HEAT TRANSFER IN LAMINAR FLOW THROUGH A TUBE. I.Abramowitz, W.F.Cahill and C.Wade, Jr.

. Res. Nat. Bur. Stand., Vol. 62, No. 3, 101-5 (March, 1959).

The problem of heat transfer due to laminar flow of a viscous uid in a channel is studied under the assumption that there is a arabolic distribution of velocity. The effect of axial temperature hanges are considered and the solution is based on the simpler ituation where axial effects are discussed. The solution, obtained y the method of least squares, is represented in terms of a set of onorthogonal characteristic functions. These functions and the cor-esponding characteristic values are determined by numerical integ-ation employing the Runge—Kutta procedure. Symptotic develop-ents are obtained which are useful in the limiting cases.

536.2.08 : 537.323

VOLUME-GRADIENT THERMOELECTRIC FORCE AND HERMAL CONDUCTIVITY IN GERMANIUM SINGLE CRYSTALS F KNOWN CRYSTALLOGRAPHIC ORIENTATION. See bstr. 5749

536.21 : 548

823. EFFECT OF DISLOCATIONS ON THE THERMAL COND-JCTIVITY OF LITHIUM FLUORIDE. R.L.Sproull, M.Moss and H.Weinstock.

. appl. Phys., Vol. 30, No. 3, 334-7 (March, 1959).

Measurements of the thermal conductivity K of Harshaw LiF rystals were made over the temperature range 2°-100°K. A reshly cleaved crystal exhibited K values in agreement with the easurements of Berman, Foster, and Ziman (1956). Annealing aised the maximum K by a factor of two. Dislocations were added y compression, and the dislocation density was determined by the ethods of Gilman and Johnston. The K values below 30°K for the eformed specimens were approximately proportional to T^2, in greement with Klemens' theory, but the reduction in K by intro-uction of dislocations was much larger than Klemens' predictions. he phonon mean free path when limited by dislocation scattering as found to be approximately $(4 \times 10^6)/DT$, where D is the number f dislocation lines/cm^2 and T is the absolute temperature.

536.21 : 537.312.62

THEORY OF THE THERMAL CONDUCTIVITY OF SUPER-ONDUCTORS. See Abstr. 5733

536.212

824. THE THERMAL CONDUCTIVITY OF GERMANIUM AT IGH TEMPERATURES. F.Kettel.

. Phys. Chem. Solids, Vol. 10, No. 1, 52-8 (April, 1959). In German.

An account is given of thermal conductivity measurements on ermanium monocrystals, both intrinsic and with high hole-conduc-ivity. Mobility values were taken, together with values for the width f the forbidden zone and its dependence on temperature (all neces-ary for theoretical discussion of the electronic component of thermal conductivity), from the measurements of other authors, and were confirmed by comparison with the present measurements of thermoelectric force and electrical conductivity. The measured values of the electronic component of thermal conductivity, of both intrinsic and hole-conductive germanium, are about 4 times as high as those determined theoretically.

536.212 : 537.311.33

6825. EXPERIMENTAL STUDIES ON THE THERMAL CONDUCTIVITY IN SEMICONDUCTORS. Y.Kanai and R.Nii.

J. Phys. Chem. Solids, Vol. 8, 338-9, 361-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The thermal conductivities of Bi_2Te_3, PbTe and InSb were measured in the temperature range 100°-600°K by Angström's method. The results, which are self-consistent, do not show the anomalous behaviour reported by some previous observers. J.B.Birks

536.212 : 537.311.33

6826. THERMAL CONDUCTIVITY OF GERMANIUM IN THE TEMPERATURE RANGE 300°-1080°K. B.Abeles.

J. Phys. Chem. Solids, Vol. 8, 340-3, 361-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Measurements were made of the thermal and electrical conductivity of four n-type germanium specimens. The results agree well with Kettel's data up to 600°K, and with Joffe's data at high temperatures, but differ outside these ranges. The thermal conductivity is analysed into two components, the lattice component which is inversely proportional to the absolute temperature, and the total electronic component which is negligible in the extrinsic range, but rises sharply when the sample becomes intrinsic. The latter component agrees qualitatively with Price's theory, but the experimental accuracy is inadequate to test the quantitative validity of the theory. J.B.Birks

536.212 : 537.311.33

APPLICATION OF THE THERMODYNAMICS OF IRREVERSIBLE PROCESSES TO CONDUCTION PHENOMENA IN SEMICONDUCTORS. See Abstr. 5674

536.212 : 537.311.33

THERMAL CONDUCTIVITY OF SiTe. See Abstr. 5709

536.22

6827. THERMAL CONDUCTIVITY OF WATER AT HIGH PRESSURES. A.W.Lawson, R.Lowell and A.L.Jain.

J. chem. Phys., Vol. 30, No. 3, 643-7 (March, 1959).

The thermal conductivity of water was measured between 30° and 140° C at pressures ranging up to 8000 kg/cm^2 using Bridgman's concentric cylinder technique. At atmospheric pressure, the values obtained are about 1% less than the most probable values estimated by Powell. At higher pressures, the values agree well with Bridgman's measurements where the data overlap. The results are discussed in terms of Hall's two fluid model of water.

536.23

6828. THERMAL CONDUCTIVITY AND EUCKEN CORRECTION FOR DIATOMIC GASES AND BINARY GAS MIXTURES. B.N.Srivastava and R.C.Srivastava.

J. chem. Phys., Vol. 30, No. 5, 1200-5 (May, 1959).

The thermal conductivity of pure oxygen, nitrogen, and hydrogen gases and of the binary gas mixtures O_2—A, N_2—A, and H_2—A at several concentrations have been measured by using a thick-wire conductivity cell at 38° C. These data have been used to calculate the Eucken factor for the diatomic gases and the binary gas mixtures. The experimental value of the thermal conductivity and the Eucken factor have been compared with the theoretical values obtained on the Lennard-Jones (12:6) model. Hirschfelder's recent expression for the thermal conductivity of polyatomic gas mixtures has also been tested at some length. It is found that Hirschfelder's expression is substantially correct in its dependence on the individual conductivities.

536.252

6829. EFFECT OF SPIN ON NATURAL CONVECTION IN MERCURY HEATED FROM BELOW. D.Dropkin and S.Globe.

J. appl. Phys., Vol. 30, No. 1, 84-9 (Jan., 1959).

In the absence of spin, natural convection between two horizontal surfaces in mercury heated from below is found to be given by the formula $N = 0.051 R^{1/3}$ where N is the Nusselt number and R the Rayleigh number. Spinning the mercury about a vertical axis reduces the amount of convection after a certain value of the spin

(Taylor number) is exceeded. This value of the Taylor number increases with increasing heat flux. Turbulent fluctuation of the temperatures of the bounding surfaces are observed and under some circumstances periodic oscillations of the temperature of the bounding surface are also noted.

536.252 : 532.59

6830. THERMAL INSTABILITY OF VISCOUS FLUIDS. C.S.Yih.
Quart. appl. Math., Vol. 17, No. 1, 25-42 (April, 1959).

The stability of a viscous fluid in an insulated vertical tube or between insulated vertical planes when a negative temperature gradient is maintained in the upward direction depends on the magnitude of this gradient, the gravity, the geometry of the solid boundary, the properties of the fluid, and the wavelength of the disturbance. The relationships between these variables for neutral stability are presented, together with the results concerning the effect of rotation on stability.

536.3 : 535.23

SPECTRAL EMISSIVITY OF TUNGSTEN. See Abstr. 6671

536.33.08 : 535.23.08

POSSIBILITIES AND LIMITATIONS OF INFRARED IMAGE CONVERTORS. See Abstr. 6672

536.413

6831. THERMAL EXPANSION OF ⟨UN⟩, ⟨UO_2⟩, ⟨$UO_2 \cdot ThO_2$⟩, AND ⟨ThO_2⟩.
C.P.Kempter and R.O.Elliott.
J. chem. Phys., Vol. 30, No. 6, 1524-6 (June, 1959).

The thermal expansion of polycrystalline ⟨UN⟩, ⟨UO_2⟩, $UO_2 \cdot ThO_2$ solid solution, and ThO_2 were determined between room temperature and ≃ 1000°C by means of X-ray diffraction techniques. For the range 26° to 1000°C, the values of the average linear thermal expansion coefficients ($\alpha \times 10^6$ per deg C are 8.61, 10.52, 10.18, and 9.32, respectively. A comparison of the observed ⟨$UO_2 \cdot ThO_2$⟩ lattice constants with those obtained by calculation indicates that the solid solution becomes less ideal as the temperature increases.

536.413

6832. THERMAL EXPANSION OF SODIUM CHLORATE AND BROMATE. S.Ganesan.
J. Indian Inst. Sci. A, Vol. 41, No. 1, 9-15 (Jan., 1959).

The thermal expansion of sodium chlorate was measured from −151.3° to +11.4°C and is found to join up well with the high temperature data of Sharma (1950). Sodium bromate was investigated from −149° to +171.5°C. The high temperature data are not in agreement with Sharma's values. Using an approximate vibration spectrum, which corresponds roughly with the observed Raman effect data, the specific heat and thermal expansion of sodium chlorate can be satisfactorily accounted for. The empirically chosen Grüneisen constants for the internal and lattice oscillations to account for the thermal expansion correspond closely to the values determined from the temperature variation of Raman spectrum for this crystal.

536.413

6833. COEFFICIENT OF THERMAL EXPANSION OF BARIUM TITANATE. J.G.R.Keyston, J.D.Macpherson and E.W.Guptill.
Rev. sci. Instrum., Vol. 30, No. 4, 246-8 (April, 1959).

A method is presented for the determination of the coefficient of thermal expansion of solids, particularly in the low-temperature region. The method is based on the measurement of the resonant frequency of one or more modes of a microwave cavity made of the material for which the coefficient of expansion is required. A change in length of 5 parts in 10^6 can be detected. This accuracy is primarily determined by the Q of the resonant cavity. Measurements of the thermal expansion of copper and barium titanate are presented over the temperature range of −200° to +100°C and the former is compared with observations made by other techniques.

536.413.2 : 548.736.4

6834. THE THERMAL EXPANSION OF CUBIC BARIUM TITANATE ($BaTiO_3$) FROM 350°C TO 1050°C. J.A.Bland.
Canad. J. Phys., Vol. 37, No. 4, 417-21 (April, 1959).

The lattice spacing was measured as a function of temperature by means of a Unicam X-ray camera. The relation between a_0 (in A) and t between 350° and 1050°C is:

$$a_0 = 4.0062 + 3.00 \times 10^{-5}\,t + 1.95 \times 10^{-8}\,t^2.$$

The maximum systematic error in a_0 is 0.0005 A. The linear expansion coefficient varies in an approximately linear fashion between 10.8×10^{-6} per deg. C at 350°C to 17.5×10^{-6} per deg. C at 1050°C.

536.413.2

6835. THERMAL EXPANSION OF ICE. T.R.Butkovich.
J. appl. Phys., Vol. 30, No. 3, 350-3 (March, 1959).

Linear thermal expansion coefficients of natural and artificial single ice crystals, commercial ice, and snow ice were determined in the temperature range near 0° to −30°C. There was no measurable difference in the coefficients of linear thermal expansion parallel and normal to the c axis of single crystals or polycrystalline ice. However, a steady decrease of expansion coefficients with each succeeding measurement on the same ice specimen was observed. The total decrease was of the order of 2×10^{-6}, while an estimated error calculation yielded a value of about 4×10^{-7}. An entirely satisfactory explanation of this phenomenon cannot be given at this time, and further investigation on this point would be desirable. Values of C_V, the specific heat at constant volume, were calculated from thermodynamic relationships. Average C_p/C_V values were 1.030. Gruneisen's constant was found to average 0.78, and essentially independent of temperature between 0°C and −30°C.

536.414

6836. DENSITY CHANGE IN SILICON UPON MELTING.
R.A.Logan and W.L.Bond.
J. appl. Phys., Vol. 30, No. 3, 322 (March, 1959).

The density of both solid and liquid silicon has been measured in the vicinity of its melting point. From the average of several determinations, the increase in density upon melting is 9 ± 1%.

536.422 : 537.533 : 621.385.032.213.13

EVAPORATION OF BARIUM FROM CATHODES IMPREGNATED WITH BARIUM—CALCIUM—ALUMINATE.
See Abstr. 5793

536.423 : 541.127

6837. VAPORIZATION OF BERYLLIUM OXIDE AND ITS REACTION WITH TUNGSTEN.
W.A.Chupka, J.Berkowitz and C.F.Giese.
J. chem. Phys., Vol. 30, No. 3, 827-34 (March,1959).

The composition of the vapour above beryllium oxide held in a tungsten Knudsen cell in the range 1900°-2400°K was determined mass spectrometrically. The vapour consists predominantly of Be and O atoms and $(BeO)_3$ and $(BeO)_4$ molecules. Smaller amounts of the following molecules were detected: O_2, BeO, $(BeO)_2$, $(BeO)_5$, $(BeO)_6$, WO_2, WO_3, and $WO_x \cdot (BeO)_y$ where $x = 1, 2$ and $y = 1, 2, 3$. A thermodynamic treatment of the data yielded a value of 4.6 ± 0.1 eV for the dissociation energy of the BeO molecule. Heats of vaporization have been measured for the other $(BeO)_4$ molecules and the data suggest a ring structure for these molecules. The boiling point of BeO has been crudely estimated as 3850 ± 200°C at which temperature the vapour consists mostly of $(BeO)_n$ and somewhat smaller amounts of $(BeO)_3$ and $(BeO)_5$. The atomization energies of the WO_2 and WO_3 molecules were measured to be 13.6 ± 0.4 and 19.3 ± 0.4 eV respectively. The dissociation energy of the WO molecule is estimated to be about 7.2 eV.

536.423.4

6838. CONDENSATION IN NOZZLES. K.A.Wilde.
J. appl. Phys., Vol. 30, No. 4(1), 577-80 (April, 1959).

The extent of realization of vapour—liquid phase equilibrium in nozzles was investigated as a function of initial particle size, kineti parameters, and nozzle dimensions. It was shown that condensation will occur on already present particles only for very small sizes and/or large nozzles 20-30 in. or more in diameter. The present rather rudimentary state of knowledge of spontaneous nucleation does not enable any reliable evaluation of condensation by this mechanism.

536.423.8 : 551.57

6839. THE INFLUENCE OF MONOLAYERS ON EVAPORATION FROM WATER STORAGES. II. EVAPORATION AND SEEPAGE FROM WATER STORAGES. W.W.Mansfield.
Austral. J. appl. Sci., Vol. 10, No. 1, 65-72 (March, 1959).

For Pt I, see Abstr. 260/1959. The influence of depth of water upon the annual evaporative cycle of a water storage is estimated. The relations between storage evaporation and losses from an evaporimeter are outlined. It is shown that seepage losses from a storage may be determined from variations in its total chloride ion content.

536.423.8 : 551.57

6840. THE INFLUENCE OF MONOLAYERS ON EVAPORATION FROM WATER STORAGES. III. THE ACTION OF WIND, WAVE, AND DUST UPON MONOLAYERS. W.W.Mansfield.
Austral. J. appl. Phys., Vol. 10, No. 1, 73-84 (March, 1959).

For Pt II, see preceding abstract. The nature of the ravages o wind, wave, and dust upon monolayers spread upon exposed surfaces of water are examined and some estimates are made of the resulting average losses of material from a monolayer of cetyl alcohol.

536.424.1 : 539.58

6841. COMPRESSION AND THE α—β PHASE TRANSITION OF PLUTONIUM. P.W.Bridgman.

J. appl. Phys., Vol. 30, No. 2, 214-17 (Feb., 1959).

Measurements of various effects of pressure on plutonium made during the war are now revealed. Compressions on the alpha phase were measured at room temperature to 40 000 kg/cm^2 in one apparatus and to 100 000 in another. The total volume compression under 100 000 is very close to 10%. Compressibility decreases with increasing pressure as is normal. Exploration for other transitions was made to 20 000 kg/cm^2 at 100° and 200° — none were found. The pressure and the volume change of the alpha-beta transition was measured at 162.6° and 205°. The transition curve is "normal", the pressure rising with increasing temperature with downward curvature, and volume increment decreasing. The volume increment averages nearly 9%. The pressure of transition at 205° is very approximately 7000 kg/cm^2. The calculated latent heat of transition at the mean pressure is roughly 4.5 cal/g.

536.44

6842. EXACT LATTICE-CLUSTER EXPANSION FOR THE FROST POINTS OF ARGON—KRYPTON GAS MIXTURES.

J.F.Walling and G.D.Halsey, Jr.

J. chem. Phys., Vol. 30, No. 6, 1514-17 (June, 1959).

The frost points of argon—krypton mixtures at various pressures and compositions of the gas phase have been determined. These results have then been analysed by a generalized form of regular solution theory, where the energy of mixing parameter w_{AB} has been allowed to vary with mole fraction as well as temperature. The results have been compared with an exact expansion in terms of Mayer cluster sums of the lattice-solution (Ising) model. The model does not entirely account for the data.

536.45

6843. THE OPACITY AT HIGH TEMPERATURES DUE TO COMPTON SCATTERING. D.H.Sampson.

Astrophys. J., Vol. 129, No. 3, 734-51 (May, 1959).

The contribution to the radiative opacity of matter arising from Compton scattering is obtained for the entire region in which degeneracy in the electron distribution may be neglected. This corresponds to temperatures up to about 125 keV (1 keV = 11605800° K) and densities up to roughly 10^4 gm cm^{-3} at the highest temperatures considered. It is found that, at temperatures for which the Klein—Nishina cross-section should be used, parts of the scattering into and out of a beam of radiation do not cancel, as previously assumed. The result of this is to lower the opacity by about 13% at kT = 20 keV and 37% at kT = 125 keV. Although absorption resulting in pair-creating may be neglected at these temperatures, it is found that pair-production is responsible in another way for a sharp rise in the opacity by increasing the density (N) of electrons and positrons significantly at the highest temperatures considered. In fact, at kT = 125 keV. the value of N corresponding to thermal equilibrium is large and almost independent of the matter density (ρ), where ρ does not include the mass of the electrons and positrons resulting from pair-creation. Hence we conclude that for $kT > 125$ keV, the average mean free path $\Lambda_C = (\rho K_C)^{-1}$ is small and independent of ρ. On the other hand, for $kT < 30$ keV, we have the familiar situation that the Compton opacity (K_C) is small and independent of ρ.

536.46 : 534.39

6844. COMBUSTION INSTABILITY: ACOUSTIC INTERACTION WITH A BURNING PROPELLANT SURFACE.

R.W.Hart and F.T.McClure.

J. chem. Phys., Vol. 30, No. 6, 1501-14 (June, 1959).

A theory of the response of a burning solid to a sound wave is developed, based on time-dependent solutions of the transport equations relevant to a combustible having idealized physical and chemical properties. The development is restricted to small perturbations about the steady-state conditions for a rather simple model whose parameters have either a direct physical significance, or are experimentally determinable. The introduction of ad hoc time delays, or other phenomenological parameters has been entirely avoided. Time-dependent reaction rate chemistry also has been avoided, by considering only sufficiently fast reactions that the volumetric rate of reaction corresponds to the steady-state rate appropriate to the instantaneous local conditions as described by solution of the time-dependent transport equations. The predictions of the theory are discussed briefly, and several rather general observations are made. However, in view of the complexity inherent in the phenomenon and the present state of inadequate available empirical knowledge regarding this phenomenon, it is not yet possible to make a quantitative comparison between the theory and experiment.

536.48

6845. THE PROPERTIES OF THE SATURATED HELIUM FILM.

L.C.Jackson and W.G.Grimes.

Advances in Phys., Vol. 7, 435-78 (Oct., 1958).

A comprehensive and critical exposition of experimental work and its discussion in the light of various theoretical approaches. The relevant properties are: (1) The film thickness, which depends on the height above the liquid surface, on the temperature and on the nature of the substrate; the latter effect is not yet fully explored. (2) The transfer rate, which is sensitive to impurities, depends on temperature roughly as the superfluid density; some recent work which points to an increase of transfer rate below 0.8° K is mentioned. The dependence of transfer rate on the film thickness is not yet well established experimentally. Several theoretical attempts predict different behaviour. The conditions are indicated under which drops of bulk liquid form from the film, and the double beaker experiments are described, which constitute the clearest examples of the frictionless subcritical flow. 59 references. H.London

536.48

6846. EXCITATIONS IN LIQUID HELIUM: NEUTRON SCATTERING MEASUREMENTS.

J.L.Yarnell, G.P.Arnold, P.J.Bendt and E.C.Kerr.

Phys. Rev., Vol. 113, No. 6, 1379-86 (March 15, 1959).

The energy-momentum spectrum of the excitations in liquid helium II was measured in a neutron scattering experiment. At T = 1.1° K, data were obtained in the momentum range $p/\hbar = 0.55$ to 2.36 A^{-1}. The results bear a striking resemblance to the spectrum proposed by Landau in 1947. If a phonon spectrum of the form $E = v_1 p$ is fitted to the point at $p/\hbar = 0.55$ A^{-1}, a value of 239 ± + 5 m/sec is obtained for v_1. The measured spectrum passes through a maximum of $E/k = 13.92 \pm 0.10$° K at $p/\hbar = 1.11 \pm 0.02$ A^{-1} There is a minimum at $p/\hbar = 1.92 \pm 0.01$ A^{-1}, which may be represented by Landau's roton expression, $E = \Delta + (p - p_0)^2/2\mu$, with $\Delta/k = 8.65 \pm 0.04$° K, $p_0/\hbar = 1.92 \pm 0.01$ A^{-1}, $\mu = (0.16 \pm 0.01) m_{He}$. Above $p/\hbar = 2.18$ A^{-1}, the spectrum rises linearly with a slope corresponding to the velocity of first sound. Data were obtained in the region of the minimum at T = 1.6° K and at T = 1.8° K. The spectrum has the same general shape observed at T = 1.1° K, shifted downward by 0.22° K at 1.6° K, and by 0.50° K at 1.8° K. The temperature variation may be represented by the empirical expression $\Delta/k = 8.68 - 0.0084\,T^7$ °K. At the higher temperatures, the energy spread of the excitations was larger than the energy resolution of the apparatus. The observed full width at half maximum was ~ 1° K at T = 1.6° K, and ~ 2° K at T = 1.8° K.

536.48

6847. EXCITATIONS IN LIQUID HELIUM: THERMODYNAMIC CALCULATIONS. P.J.Bendt, R.D.Cowan and J.L.Yarnell.

Phys. Rev., Vol. 113, No. 6, 1386-95 (March, 15, 1959).

The entropy, specific heat, normal fluid density, and velocity of second sound in liquid helium II were calculated by applying statistical mechanics to the thermal excitations. The calculations were based on the energy-momentum relation obtained by neutron scattering measurements described by Yarnell, Arnold, Bendt and Kerr (preceding abstract), and were made on an IBM-704 electronic digital computer by numerical integrations over the observed excitation curve. A better approximation than Landau's was obtained by extending Landau's theory to take account of the temperature dependence of the excitation curve. An expression of the form $E(p,T) = c - d(\rho_n/\rho)$ was used to interpolate the excitation energy between temperatures at which it was measured. Results between 0.2 and 1.8° K are not sensitive to the exact form of the interpolation expression. Agreement of the calculations with experimental measurements is as follows: entropy, ±3% in the temperature range 0.2 to 1.8° K; specific heat, ±4% between 0.2 and 1.7° K; second sound velocity, ±4% between 0.8 and 1.8° K, and ±2% between 1.0 and 1.7° K. The calculated normal fluid density ρ_n agrees with experimental values derived from second sound velocity and specific heat measurements within ±8% between 0.7 and 2.0° K, and within ±5% from 1.1 to 1.9° K. These values are, however, higher than those obtained from torsion pendulum measurements, which are 27% below the calculated value at 1.2° K. Also calculated as functions of temperature are the average effective mass (as defined by Landau) of excitations in four momentum intervals, and values of $-\kappa/\bar{B}$, the thermal conductivity λ divided by the average over momentum of the Khalatnikov nonequilibrium kinetic coefficient –B, and $\eta/\bar{C}$, the viscosity η divided by the average value of the Khalatnikov coefficient C.

536.48

6848. LANDAU'S MODEL OF LIQUID He^3. T.Usui.
Phys. Rev., Vol. 114, No. 1, 21-6 (April 1, 1959).

Landau's model of liquid He^3 as a Fermi liquid is studied with regard to its lowest temperature properties. Primary stress is laid on the coefficient of thermal expansion. The spectra used by Abrikosov and Khalatnikov, the perfect-gas type and "bubble" type, are shown to give a positive coefficient of thermal expansion, in contradiction with experiment. An alternative simple spectrum is suggested which can give a negative coefficient of thermal expansion, namely $\Delta + p^2/2m^*$. In addition, the existence of a negative coefficient of thermal expansion is shown to imply a strong temperature dependence of the energy spectrum, which may cause a sharp deviation of the heat capacity curve from the perfect-gas type, similar to the deviations observed in liquid He^3.

536.48 : 539.18

6849. EXPERIMENTAL WORK WITH ^3He.
V.P.Peshkov and K.N.Zinov'eva.
Rep. Progr. Phys., Vol. 22, 504-61 (1958).

Describes all aspects of experimental work on He^3: methods of extracting He^3 from a mixture of isotopes and the sources from which it is obtained, details of the most efficient methods and apparatus, experiments on saturated vapour pressure and the critical point, the equation of state of gaseous He^3, thermomolecular pressure rates, melting curve and $\alpha-\beta$ transition in solid He^3, experiments and data on the density of liquid, gaseous and solid He^3, the thermal properties of He^3 — latent heat, specific heat and entropy — the magnetic properties of He^3, and the phenomena of viscosity and thermal conductivity, results of experiments on the temperature discontinuities at the boundary between He^3 and a solid, the velocity of sound, the compressibility of He^3 and adsorption on activated charcoal, the construction and specifications of the work of cryostats, which enable one to obtain and maintain temperatures to 0.3°K by pumping off He^3 vapour. The possibility is discussed of obtaining and maintaining temperatures below 0.3°K by adiabatic crystallization of He^3. The article reviews with brief critical comments practically all published experimental work on the investigation of He^3, and gives tables and graphs for all known properties of He^3.

536.512

6850. A CALIBRATION METHOD FOR THE MERCURY THERMOMETER. M.Şchiopu, V.Onu and M.Păstrăvanu.
Bul. Inst. Politeh. Iasi, Vol. 4(VIII), No. 1-2, 135-8 (1958).
In German.

A travelling microscope is used not only to calibrate the capillary by measuring the length of a mercury column at different positions along the capillary, but also to measure the distances between the scale graduations to within two microns. The corresponding correction to be applied to the thermometer reading is considered. S.Weintroub

536.52

6851. PRACTICAL ASPECTS OF RADIATION PYROMETRY. T.Land.
Trans Soc. Instrum. Technol., Vol. 11, No. 1, 10-18 (March, 1959).

The selection, installation and use of radiation pyrometers are explained. Methods are described for determining the true temperature of a surface by radiation methods. The advantages and limitations of photoelectric pyrometers are considered. Typical applications in a wide variety of industries are used to illustrate the principles. A short table of emissivities of industrial surfaces is given, together with tables of corrections for different kinds of radiation pyrometer.

536.52

6852. ON THE BLACK BODY TEMPERATURE OF AN IMMERSION RADIATOR AT THE GOLD-POINT. H.Wagenbreth.
Z. angew. Phys., Vol. 10, No. 11, 521-5 (Nov., 1958). In German.

The radiator considered, which is used in conjunction with an optical pyrometer, consists of a hollow sphere with cone shaped trumpet entry and is immersed in the gold. Formulae and numerical values for the black body temperature, the energy loss through the spherical opening and for the temperature gradient along the wall of the trumpet are derived and compared with measured values, for various sizes of openings. S.Weintroub

536.521

6853. RECORDING OPTICAL PYROMETER. N.A.Blum.
Rev. sci. Instrum., Vol. 30, No. 4, 251-3 (April, 1959).

A recording pyrometer which measures the brightness temperature at 0.65 μ of a small incandescent sample in the range 1300°C to above 3000°C with a time constant of a few milliseconds is described. The instrument, designed to be used in studies of materials exposed to the plasma jet of a high-intensity electric arc, is reliable to within ±20°C, and is suitable for measuring transient high-temperature fluctuations or for applications where use of a standard optical pyrometer might be hazardous to personnel.

536.6 : 536.7

6854. HEAT CAPACITIES AND THERMODYNAMIC PROPERTIES OF THE IRON TELLURIDES $Fe_{1.11}Te$ AND $FeTe_2$ FROM 5 TO 350°K. E.F.Westrum, Jr, Chien Chou and F.Grønvold.
J. chem. Phys., Vol. 30, No. 3, 761-4 (March, 1959).

Heat capacities of the two iron telluride phases, $Fe_{1.11}Te$ and $FeTe_2$, were measured in the range 5° to 350°K. In $Fe_{1.11}Te$ a cooperative type of transformation was observed at about 63°K involving an entropy increment of 0.57 cal/mole °K. The thermodynamic functions were evaluated and the values of C_p, $S°-S_0°$, and $(H°-H_0°)/T$ at 298.15°K are 13.15, 21.272, and 9.575 cal/mole °K, respectively, for $Fe_{1.11}Te$, and the values of C_p, $S°-S_0°$, $H°-H_0°$, and $-(F°-H_0°)/T$ for $FeTe_2$ are 17.60 and 23.940 cal/mole °K, 3567.4 cal/mole, and 11.975 cal/mole °K, respectively.

536.631

6855. HEAT CAPACITY OF SMALL PARTICLES OF MgO BETWEEN 1.5° and 4°K. W.H.Lien and N.E.Phillips.
J. chem. Phys., Vol. 29, No. 6, 1415-16 (Dec., 1958).

The measurements described were made on material prepared by the dehydration of MgO at 350°C. The surface area of the sample was 166 m^2/g and the estimated thermal conductivity 5×10^{-8} watt cm^{-1} deg^{-1}. A thin walled Cu calorimeter, attached to a carbon resistance thermometer and a heater, was used. S.Weintroub

536.631 : 537.226.2 : 539.2

THERMAL STUDY OF $(NH_4)_2SO_4$ AND $(NH_4)_2BeF_4$.
See Abstr. 6265

THERMODYNAMICS

536.7

6856. SYSTEMATIC APPROACH TO THE CALCULATION OF THERMODYNAMIC TRANSFORMS. C.W.Carroll.
Amer. J. Phys., Vol. 27, No. 5, 302-6 (May, 1959).

In thermodynamics, transformation of intangible partial derivatives (for single-phase, constant-mass systems) into an experimentally measurable or easily calculable form is often necessary. Appropriate transformations may be systematically and efficiently derived by employing a minimum of basic thermodynamic concepts and applying selected mathematical techniques (including a limited use of Jacobians). It is hoped that the particular approach suggested will help students avoid gross memorization and artificial mnemonic or tabular schemes. In so doing, greater familiarity should be developed with the thermodynamic and mathematical interrelationships involved.

536.7

6857. THERMODYNAMIC FUNCTIONS OF SODIUM CYANATE AND POTASSIUM CYANATE. J.Roth.
J. chem. Phys., Vol. 30, No. 2, 596-7 (Feb., 1959).

The standard free energy of formation, calculated from solubilit data, was found to be –85.9 kcal/mole for NaCNO and (approx.) –89.3 kcal/mole for KCNO. For the sodium salt the standard entrop was computed; found 28.5 e.u. C_p was determined to be 20.7 cal per deg. per mole. W.Good

536.7

6858. FREE ENERGY OF A NONUNIFORM SYSTEM.
II. THERMODYNAMIC BASIS. J.W.Cahn.
J. chem. Phys., Vol. 30, No. 5, 1121-4 (May, 1959).

The thermodynamic treatment of nonuniform systems of Pt I (Abstr. 8612/1958) is shown to be equivalent to the self-consistent thermodynamic formalism of Hart. All parameters of the two treatments have been rigorously related and key equations were shown to be equivalent.

536.7
59. THERMODYNAMICS OF INHOMOGENEOUS SYSTEMS. II.
W.Hart.
ys. Rev., Vol. 114, No. 1, 27-9 (April 1, 1959).
For Pt I, see Abstr. 4538 (1959). By the inclusion of an explicit
pendence of the energy on the boundary of the system, the thermo-
namic description of inhomogeneous systems is made more com-
ete. In particular, virtual processes can then be defined that
termine the measurable stresses everywhere in the system.

536.71 : 534.222.2
60. DETERMINATION OF THE UNREACTED HUGONIOT FOR
QUID TNT. W.B.Garn.
chem. Phys., Vol. 30, No. 3, 819-22 (March, 1959).
An optical technique was used to measure the state behind
h-explosive induced shock waves in unreacted liquid TNT. Data
e reported which determine the unreacted Hugoniot for this mate-
l, at an initial temperature of 81°C, over the pressure range
om 45 to 110 kilobars.

536.71 : 535.343 : 535.375.5
61. THERMODYNAMIC AND SPECTROSCOPIC STUDY OF
NYLIDENE CHLORIDE. I. THERMODYNAMIC PROPERTIES OF
E SOLID, LIQUID, AND IDEAL GAS.
L.Hildenbrand, R.A.McDonald, W.R.Kramer and D.R.Stull.
chem. Phys., Vol. 30, No. 4, 930-4 (April, 1959).
The low-temperature heat capacity, heat of vaporization and
pour pressure were measured. Data obtained are as follows:
heat capacity of the solid from 13° to 150°K; the liquid heat
pacity from 150° to 290°K; the heat of fusion, 1557 cal $mole^{-1}$, at
melting point, 150.59°K; the entropy of the liquid at 298.15°K,
.17 cal $mole^{-1}$ deg^{-1}; the heat of vaporization at 298.15°K,
28 cal $mole^{-1}$; and the vapour pressure, $\log_{10}P(mm) = 6.98200 -$
04.29/(t + 237.70). The entropy of the ideal gas, evaluated from
calorimetric data, is in agreement with the entropy calculated
om spectroscopic and molecular data. Thermodynamic properties
the solid, liquid, and ideal gas are tabulated at selected temper-
res.

536.71 : 535.375.5 : 535.343
THERMODYNAMIC AND SPECTROSCOPIC STUDY OF
NYLIDENE CHLORIDE. II. See Abstr. 6735

536.75
62. ALTERNATE PROOF OF THE EXISTENCE OF THE
NTROPY FUNCTION. A.A.Evett.
ner. J. Phys., Vol. 27, No. 5, 361-3 (May, 1959).
A proof is presented for the exactness of dQ/T based on
owing directly that the reciprocity conditions are satisfied if one
sumes the validity of Carnot's theorems.

536.8 : 537.322
63. ON THE THEORY OF THE PELTIER HEAT PUMP.
S.Rittner.
appl. Phys., Vol. 30, No. 5, 702-7 (May, 1959).
The figure of merit for a single stage Peltier heat pump is
timized in the region of partial Fermi degeneracy. A more
gorous treatment is presented of the properties of a cascade opera-
g at maximum coefficient of performance. Finally, the heat leak
the absence of current flow is called to attention as a serious pro-
em in devices with excess capacity.

ELECTRICITY

ELECTROSTATICS . DIELECTRICS

537.213 : 537.533
64. DETERMINATION OF ELECTROSTATIC POTENTIALS BY
RIES. R.Gáspár, B.Koltay-Gyarmati and I.Tamássy-Lentei.
cta phys. Hungar., Vol. 9, No. 4, 369-80 (1959).
If the charge distribution can be expressed by the Dirac δ-func-
on, the potential distribution can be given in the form of a series,
e convergence of which is sufficiently rapid. For simple cases the
rmulae can be analytically reduced to the known solutions of cor-
sponding problems. In other cases, the calculated potential distri-
ion coincides with the potential distribution obtained by electro-
tic tank measurements. For the cylindrical electron lens, the
ethod yields the potential distribution and the corresponding elec-
ode shape for arbitrary slit width.

537.221 : 551.576
6865. THE ELECTRIC CHARGE ON CONDENSATE AND WATER DROPLETS. C.Magono and T.Takahashi.
J. Meteorol., Vol. 16, No. 2, 167-72 (April, 1959).

It was found that dew produced artificially on a thin wire was electrified negatively when the water temperature of the reservoir for supplying water vapour was lower than about 80°C, and positively when the temperature was higher than about 85°C. The electrification phenomena of the condensate were considered to be originated from the electric charge on individual water droplets, because it was observed that the droplets were electrified when they rose from the water surface of the reservoir, and the sign of charge on the individual droplets agreed well with that of the condensate.

537.222.31
6866. DIELECTRIC LOSS IN 66 NYLON (POLYHEXAMETHYLENE ADIPAMIDE). R.H.Boyd.
J. chem. Phys., Vol. 30, No. 5, 1276-83 (May, 1959).

The dielectric loss in 66-nylon (polyhexamethylene adipamide) was studied over a range of temperatures (-40° to 100°C) and frequencies (50 c/s-70 Mc/s). The effects of radiation induced crosslinking and hydrogen bonding solutes were studied. The principal dipole orientation absorption is similar to that in amorphous polar polymers in that it involves long chain segment rearrangements in the amorphous regions. However no temperature range was found in which the distribution of relaxation times is independent of temperature, thus there is no time-temperature superposition. The effect of crosslinking allows a semiquantitative estimate of the segment length of about 15 amide groups to be made. The plasticizing effect of the solutes and their effect on the activation energy for dielectric absorption and the relaxation time distribution is discussed. The static dielectric constant associated with the long chain segment rearrangement mechanism is derived. From its temperature and solute dependence, the equilibrium disappearance of this mechanism at low temperatures is inferred. This disappearance seems to be associated with increased interchain coupling. The solute dependence also shows the presence of tightly bound solute molecules at the amide groups. A weak absorption occurring at lower temperatures (-10°C and 100 c/s) is also observed. Comparison of the dielectric absorption with mechanical absorption is made.

537.224 : 537.56 : 621.319.4
6867. HYDROMAGNETIC CAPACITOR.
O.Anderson, W.R.Baker, A.Bratenahl, H.P.Furth and W.B.Kunkel.
J. appl. Phys., Vol. 30, No. 2, 188-96 (Feb., 1959).

Very high dielectric constants can easily be achieved by means of an ionized gas in a strong magnetic field. When an orthogonal electric field is applied, the resultant particle drift stores electrical energy. In a coaxial capacitor, which makes use of a rotating plasma disk, dielectric constants in the range 10^6 to 10^8 have been measured. The potential usefulness of hydromagnetic capacitors in fast-discharge work is considered.

537.226 : 621.315.61
6868. PROGRESS IN DIELECTRICS. VOLUME I.
Edited by J.B.Birks and J.H.Schulman.
London: Heywood and Company (1959) ix + 312 pp.

The first volume in an annual series, which aims to coordinate current knowledge of dielectric phenomena, materials and techniques and to review recent progress. It contains 7 review articles, for which see Abstr. 6873-6, 7034, 7036-7 (1959).

537.226
6869. A CONVENIENT NEW FORM OF ONSAGER'S EQUATION FOR THE DIELECTRIC CONSTANT OF POLAR SOLUTIONS.
R.N.Work.
J. phys. Chem., Vol. 63, No. 4, 548-51 (April, 1959).

Onsager's equation for the dielectric constant of solutions of polar molecules in polar or non-polar solvents has been recast to express the relation between the dipole moments of the polar molecules present and $\epsilon_S - \epsilon_\infty$ the orientational contribution to the dielectric constant, where ϵ_S is the static dielectric constant and ϵ_∞ is the high frequency dielectric constant. The new form of Onsager's equation is convenient to use and is valid over the whole range of solution concentrations, within the limitations of Onsager's model. The effect of the free volume of the solution has been included. It is shown that serious errors can be introduced by the usual assumption that the volume actually occupied by the molecules is equal to the volume of the solution. The new equation is particularly useful in studies of short range forces that lead to directional correlations between polar molecules, or in studies of the asphericity of molecules.

537.226.1

6870. THE EVALUATION OF DIELECTRIC DATA FOR LIQUIDS AND SOLUTIONS. G.Williams.
J. phys. Chem., Vol. 63, No. 4, 537-40 (April, 1959).

A number of useful modifications and correlations of current methods of evaluating the dielectric parameters for polar liquids and solutions are described and illustrated by examples. These include the comparison and correlation of the "dilute solution" and "pure liquid" equations for the relaxation time, simple graphical methods for determining the relaxation time and its distribution factor in the general cases, and the calculation of dipole moments via Guggenheim's relations using Smyth's dielectric parameters.

537.226.1

6871. SOLUTE DIMERIZATION AND THE DIELECTRIC CONSTANT OF A SOLUTION. A.D.Buckingham and R.E.Raab.
Trans Faraday Soc., Vol. 55, Pt 3, 377-87 (March, 1959).

The total dielectric polarization of a solution in a non-polar solvent is expanded as a power series in c, the concentration of the solute. The leading term in the expansion is the total polarization of the pure solvent and the term in c leads to the well-known "apparent dipole moment" μ_S of the solute at infinite dilution. The term in c^2 is related to the properties of interacting groups containing only two solute molecules, and hence can be interpreted in terms of the mean square dipole moment $\langle m_{12}^2 \rangle$ of a "dimer". Dielectric constant data indicate that interacting molecular pairs of nitrobenzene, methyl fluoride, acetonitrile and paraldehyde tend to have their dipoles parallel in non-polar solvents, whilst there is an apparent tendency toward antiparallelism in solutions of formic, acetic and benzoic acids in benzene. A theory is developed relating the ratio of the coefficients of the terms in c and c^2 in the expansion of the total polarization of the dilute solution to $\langle m_{12}^2 \rangle$ and to K, the dissociation constant of the dimer. If the carboxylic acid dimers are non-polar then the computed Ks are about ten times those determined from other equilibrium data; if these latter Ks are used, then it is found that the benzoic acid dimer has a root mean square dipole moment of 1.74 D. Thus it is concluded that either the dimers are polar or that existing equilibrium constant data are erroneous.

537.226.1.08

6872. THE MEASUREMENT OF DIELECTRIC CONSTANT AND LOSS FACTOR OF LIQUIDS AND SOLUTIONS BETWEEN 250 AND 920 Mc/SEC BY MEANS OF A COAXIAL TRANSMISSION LINE. G.Williams.
J. phys. Chem., Vol. 63, No. 4, 534-7 (April, 1959).

A coaxial line method is described of measuring the dielectric properties of liquid systems in the frequency range 250-1000 Mc/s (or higher). The method is essentially that of Roberts, Westphal and von Hippel. Data are presented for typical systems of high and low ϵ' and ϵ'' values showing results which compare favourably with other methods in this region. Evaporation losses, access of moisture and temperature are readily controlled for the liquids.

537.226.2 : 621.315.618

6873. GASEOUS DIELECTRICS. T.W.Liao and R.E.Plump.
Progress in dielectrics, 141-70. See Abstr. 6868 (1959).

A review of the technological requirements and properties of gaseous insulation, with particular reference to polyatomic and electronegative gases. Theoretical and experimental advances, practical developments, and chemical and physical properties and effects are considered. There are 111 references. J.B.Birks

537.226.2 : 621.315.612.4

6874. FERROELECTRICITY OF BARIUM TITANATE SINGLE CRYSTALS. A.D.Franklin.
Progress in dielectrics, 171-215. See Abstr. 6868 (1959).

A comprehensive review of recent experimental and theoretical work in this field. After a short introduction in which the properties of other ferroelectric materials are summarized, the review is concerned entirely with barium titanate single crystals. Sections are devoted to the crystal chemistry of barium titanate, the preparation of crystal specimens, the classification of ferroelectric properties, and detailed discussions of the static properties, and the dynamic properties. There are 64 references. J.B.Birks

537.226.2 : 621.315.612

6875. NON-OXIDE CERAMIC DIELECTRICS. P.Popper.
Progress in dielectrics, 217-69. See Abstr. 6868 (1959).

A survey is made of the properties of the elements and the binary compounds (excluding oxides) which are potential ceramics (melting point >800°C) and dielectrics (energy gap >2eV). The survey reveals significant trends in the properties of the binary compounds, and some surprising gaps in the existing data. The preparation, properties and applications of the nitrides of boron, silicon and aluminium are treated more fully. The review includes 31 tables and 188 references. J.B.Birks

537.226.2 : 621.315.61

6876. ELECTROPHORETIC DEPOSITION OF INSULATING MATERIALS. J.B.Birks.
Progress in dielectrics, 271-312. See Abstr. 6868 (1959).

The theory and practical applications of electrophoretic deposition of dielectric materials are reviewed. Topics discussed include the different types of boundary potential, the electrical double layer, the theory of electrophoretic deposition, and technical applications to silica, carbonates, alumina and other refractories, organic resins and lacquers, and deposition of airborne particles. 90 references to scientific, technical and patent literature are given.

J.B.Birks

537.226.2

6877. THEORETICAL AND EXPERIMENTAL STUDY OF THE ELECTRICAL PROPERTIES OF ICE. C.Jaccard.
Helv. phys. Acta, Vol. 32, No. 2, 89-128 (1959). In French.

It has been shown by Gränicher [Zeitschrift für Kristallographie, Vol. 110, 432 (1958)] that the explanation of the electrical properties of ice crystals requires the existence and mobility of ionized states (H_3O^+ and OH^-) and of orientational lattice defects (doubly occupied and vacant bonds). In contrast to previous theoretical treatments, all four types of lattice defects are taken into account simultaneously and the complex electrical conductivity is computed for the cases of classical and for quantum-mechanical proton transfer. The dielectri constant which closely follows a Debye dispersion, the relaxation time and the high frequency conductivity are determined by the major ity defects, i.e. the kind of defects of highest specific conductivity. In contrast, the conductivity in static fields is determined by the minority defects. If both kinds of defects are balanced the conductivity and the dielectric constant are frequency-independent. In this case, the dielectric constant has its high frequency value $\epsilon_\infty = 3.2$ (case of pure conduction). This is the explanation for the minima observed in mixed crystals containing hydrofluoric acid. The analysis of these results leads to the conclusion that the majority mechanism in pure ice crystals is caused by orientational defects. Their mobility is measured at high frequency. The theoretical value of the mobility of H_3O^+ ions, calculated on the assumption of quantum mechanical proton transfer, is in good agreement with the experimental value of Eigen and De Maeyer [Z.Elektrochem., Vol. 60, No. 9-10, 1037-48 (1956)]. The methods for the production of pure and doped ice crystals and the high frequency equipment are describe

537.226.2 : 539.19

6878. DIELECTRIC PROPERTIES OF POLYPEPTIDE SOLUTIONS. II. RELATION BETWEEN THE ELECTRIC DIPOLE MOMENT AND THE MOLECULAR WEIGHT OF α HELIX. A.Wada.
J. chem. Phys., Vol. 30, No. 1, 328-9 (Jan., 1959).

For Pt I, see Abstr. 1411(1959). The dipole moments of a homologous series of poly-γ-benzyl-L-glutamate were measured in ethylene dichloride. A plot of the molecular dipole moment against degree of polymerization gave a linear relation from which the contribution of the dipole moment of a peptide residue to the directio of the molecular axis of the helical structure was calculated to be 3.4 Debye units. R.C.Glass

537.226.2 : 539.19

6879. DIELECTRIC PROPERTIES OF POLYPEPTIDE SOLUTIONS. III. ELUCIDATION OF THE CRITICAL FREQUENCY OF DIELECTRIC DISPERSION FROM THE MOLECULAR SHAPE OF THE α HELIX. A.Wada.
J. chem. Phys., Vol. 30, No. 1, 329-30 (Jan., 1959).

The critical frequency of poly-γ-benzyl-L-glutamate was determined for several samples of different molecular weight in ethylene dichloride. Good agreement is obtained with the theoretical relatior between critical frequency and molecular weight and shows that the α helix is fairly rigid and that the molecular model of Doty et al. is correct. R.C.Glass

537.226.2 : 532.783

6880. MICROWAVE DIELECTRIC MEASUREMENTS IN THE LIQUID CRYSTAL ETHYL p-AZOXYBENZOATE. E.F.Carr.
J. chem. Phys., Vol. 30, No. 2, 600 (Feb., 1959).

Measurements of dielectric loss in ethyl p-azoxybenzoate at

.28 cm and 5.07 cm wavelength in the temperature range 115°C to 40°C with and without a magnetic field up to 8000 gauss parallel r perpendicular to the electric field. The results confirm that a agnetic field is only effective in producing alignment if applied uring the liquid to liquid-crystal transition. J.G.Powles

537.226.2

881. DIELECTRIC ABSORPTION IN CRYSTALLINE LONG-HAIN METHYL ETHERS. J.S.Cook and R.J.Meakins.

. chem. Phys., Vol. 30, No. 3, 787-90 (March, 1959).

The dielectric properties of three long-chain methyl ethers and vo methyl ketones were measured at frequencies between 5 and $.4 \times 10^{10}$ c/s, and at different temperatures. No dielectric absorp-on was detected in the ketones. The ethers were investigated in oth the α- and the β-crystalline phases. In the β phase the ethers ave two regions of dielectric absorption, and the energy parameters ssociated with these absorptions were determined. In the α-phase, ne methyl ethers give larger dielectric absorption, which occurs ainly in the microwave region, although two of the compounds also ive a smaller peak at very low frequencies. The experimental alues of the total absorption are in good agreement with the values alculated from the dipole moment. The results suggest that the nolecules all contribute to the dielectric absorption, which is in ontrast to the situation in β-phase long-chain compounds where it as been suggested that molecular rotation occurs only at imperfec-ons in the crystal lattice.

537.226.2

882. ULTRAHIGH FREQUENCY ABSORPTION IN LIQUID IIXTURES. V.Muralidhara Rao.

. sci. industr. Res., Vol. 18B, No. 3, 103-5 (March, 1959).

The dielectric constant and dielectric loss of two liquid nixtures were studied using the standing-wave method of Roberts nd Von Hippel [J. appl. Phys., No. 17, 1610 (1946)]. The mixtures tudied were n-butyl alcohol + glycerol (both associated) and sobutyl alcohol + n-propyl bromide (associated + non-associated). 'wo peaks were observed in both cases in the ϵ''—frequency and $''$—temperature curves. Schallamach's suggestion (Abstr. 617/1948) nat the process of dielectric relaxation cannot be directly connected rith individual molecules but is a disturbance over an appreciable egion in the liquid does not appear to be valid in the present nixtures.

537.226.2

883. DIELECTRIC CONSTANT OF GERMANIUM AND SILICON S A FUNCTION OF VOLUME. M.Cardona, W.Paul and H.Brooks.

. Phys. Chem. Solids, Vol. 8, 204-6, 218 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/959). The variation of refractive index for infrared radiation $\sim 3\,\mu$) was deduced from experiments involving (a) the shift of the nterference maxima and minima in the transmission of thin single rystal films about 3-10 μ thick, and (b) the change in the angle of ninimum deviation of single crystal prisms. Pressure coefficients vere determined solely by the interference method. The tempera-ure coefficients agree well with those for the dielectric constant at ow temperatures and the pressure coefficients are in close agree-nent with those deduced from r.f. dielectric constant measurements. 'he pressure measurements confirm that the temperature depend-nce of the refractive index and the dielectric constant is very much arger than that deduced from volume effects alone. A.E.Kay

537.226.2

884. DIELECTRIC PROPERTIES OF SOME POLYCRYSTALLINE TANNATES AND CERATES. B.Piercy.

'rans Faraday Soc., Vol. 55, Pt I, 39-51 (Jan., 1959).

The dielectric constant and loss of several stannates and erates in sintered form were measured over a range of frequency 10^2-10^6 c/s) and temperature (-200° to $+400^\circ$C). In all specimens he dielectric dispersion was small at room temperature and below, ut became large at high temperatures. It is believed that this large ispersion is caused by space-charge polarization of electrons. mall absorption maxima were found in many specimens which may e caused by either a small electronic space charge or localized ion umps. No evidence of ferroelectricity was found although these xides have the perovskite crystal structure. A negative tempera-ure coefficient of capacity was observed in $BaSnO_3$ below room tem-erature.

537.226.2

885. THE DIELECTRIC BEHAVIOUR OF VAPOURS ADSORBED ON POROUS SOLIDS. J.M.Thorp.

'rans Faraday Soc., Vol. 55, Pt 3, 442-54 (March, 1959).

An investigation has been made of the changes in the apparent dielectric constant of three powdered sorbents, a silica gel, a mixed silica + ferric oxide gel and alumina, for both the adsorption and desorption of methyl alcohol, ethyl alcohol and water. Initial sorption isotherms were determined in order to calculate mean pore radii and surface areas. For each system investigated, both the isotherm and the capacity curve (the plot of total capacity increment for the gel + sorbate system, against the amount sorbed) showed a hysteresis loop, the start of which coincided with the beginning of capillary condensation. With both alumina and the mixed-oxide gel, capillary condensation was found to start after the adsorption of only one layer, whereas for the silica gel, two layers were adsorbed. Further, the capacity hysteresis loops in all alumina and mixed oxide gel + sorbate systems investigated were found to be "inverted" (i.e. the desorption branch of each loop occurred at higher pressures), in contrast to the hysteresis exhibited by the silica gel. An explanation for the hysteresis phenomena has been attempted in terms of the open-pore theory of sorption.

537.226.2

6886. ARTIFICIAL ANISOTROPIC DIELECTRICS. I. N.A.Khizhnyak.

Zh. tekh. Fiz., Vol. 27, No. 9, 2006-13 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 1858-64 (Sept., 1957).

The present work considers the anisotropic properties of an artificial dielectric made up of a normal lattice of scattering centres of arbitrary geometric shape. A new method for considering such dielectrics is suggested, making it possible to obtain general expressions for the dielectric constant and magnetic permeability tensors and to study a large number of different specific systems.

537.226.2

6887. ARTIFICIAL ANISOTROPIC DIELECTRICS. II. N.A.Khizhnyak.

Zh. tekh. Fiz., Vol. 27, No. 9, 2014-26 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 1865-76 (Sept., 1957).

Expressions are obtained for the dielectric constant and magnetic permeability tensors of an artificial dielectric consisting of normal lattices of spherical particles. Tetragonal, orthogonal, hexagonal, and monoclinic lattices are treated. The case is considered in which the field frequency is the natural frequency of the dielectric particles.

537.226.2

6888. ARTIFICIAL ANISOTROPIC DIELECTRICS. III. N.A.Khizhnyak.

Zh. tekh. Fiz., Vol. 27, No. 9, 2027-37 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 9, 1877-86 (Sept., 1957).

Expressions are obtained for the dielectric constant and magnetic permeability tensors of an artificial dielectric formed of a normal lattice of ellipsoidal particles for arbitrary orientation of these particles with respect to the lattice. The case in which the particles are ellipsoids of revolution is treated in detail. The role of multipole interactions is evaluated.

537.226.2

6889. ELECTRICAL PROPERTIES OF MULLITE [SILLIMANITE]. G.K.Kirillova.

Zh. tekh. Fiz., Vol. 28, No. 10, 2186-91 (1958). In Russian.

The dielectric losses of mullite ($3Al_2O_3.2SiO_2$) in its crystalline and amorphous state were examined. The author found that mullite free from the amorphous state has low dielectric losses. The losses depend on the baking temperature and on the amount of impurities in the components — but mainly on impurities (Na_2O, MgO, BaF_2, MgF_2, CaF_2) in the amorphous phase. Alkaline oxides present in mullite give rise to alumino silicate glass, having large losses. M.W.Makowski

537.226.2 : 536.631 : 539.2

DIELECTRIC STUDY OF $(NH_4)_2SO_4$ AND $(NH_4)_2BeF_4$.
See Abstr. 6265

537.226.2

6890. STUDY OF FERROELECTRIC TRANSITIONS OF SOLID-SOLUTION SINGLE CRYSTALS OF $KNbO_3$—$KTaO_3$. S.Triebwasser.

Phys. Rev., Vol. 114, No. 1, 63-70 (April 1, 1959).

Method of preparation and results of measurements of the dielectric constant of solid-solution single crystals of $KNbO_3$ and $KTaO_3$ are presented. Data are given for the composition range 0-80 mole % $KTaO_3$ in the temperature interval -180° to 450°C. It is found that all of the crystals studied show Curie-law behaviour of the dielectric constant in the paraelectric state. The data indicate that the paraelectric to ferroelectric transition, which is first order for pure $KNbO_3$, becomes second order at a concentration of approximately 55 mole % $KTaO_3$. Analysis of the results in terms of Slater's model of ferroelectricity in a perovskite lattice leads to the conclusion that the dependence of the Lorentz correction on volume plays a major role in determining the ferroelectric behaviour. Ionic polarizabilities and their dependence on volume are also discussed.

537.226.2

6891. ANOMALOUS POLARIZATION IN FERROELECTRICS AND OTHER OXIDES.

J.D.Hurd, A.W.Simpson and R.H.Tredgold.
Proc. Phys. Soc., Vol. 73, Pt 3, 448-54 (March, 1959).

The presence of a large relaxation polarization in a number of metal oxides is reported. It is shown that this phenomenon cannot be explained in terms of ferroelectricity or in terms of the Maxwell—Wagner effect. A series of experiments are described from the results of which it is deduced that the materials behave as solid state secondary cells. It is suggested that oxygen vacancies act as charge carriers and interact with the metal electrodes deposited on the specimen.

537.226.2

6892. EFFECT OF SPACE CHARGE FIELDS ON POLARIZATION REVERSAL AND THE GENERATION OF BARKHAUSEN PULSES IN BARIUM TITANATE.

A.G.Chynoweth.
J. appl. Phys., Vol. 30, No. 3, 280-5 (March, 1959).

The rate of generation of Barkhausen pulses in barium titanate when the polarization direction is slowly reversed is profoundly influenced by the form of the voltage cycling given to the crystal. It is concluded that the rate of nucleation of new domains is determined by the field near the electrodes which, in turn, is the resultant of the applied field and a relaxing space charge field. This result follows directly if the Barkhausen pulses represent individual nucleations, though this assumption is not crucial since the generation rate of the pulses parallels the total current at all stages of the polarization reversal. It is concluded also that the majority of the Barkhausen pulses occur independently of each other and of their surroundings.

537.226.2

6893. PULSE WIDTH DEPENDENCE OF THE SWITCHING VELOCITY IN $BaTiO_3$ CRYSTAL.

K.Husimi and K.Kataoka.
J. appl. Phys., Vol. 30, No. 3, 323-4 (March, 1959).

The maximum switching velocity $(\Delta P/\Delta t)_{max}$ $1/P_S$ in $BaTiO_3$ single crystals, obtained by the ultrasonic method, is discussed not only as the function of the applied pulse field, but also of the pulse width. Maximum switching current response (dP/dt) measured by the single pulse method and expressed as the exponential function of the field by Merz, is also considered as the limiting case of the authors' expression as the applied pulse width becomes infinitely wide.

537.226.31

6894. THE CONTRIBUTION OF MICROFISSURES TO THE DIELECTRIC LOSSES OF ANODIC OXIDE FILMS ON TANTALUM AND ZIRCONIUM AND THEIR ROLE IN ELECTROLYTIC RECTIFICATION.

L.Young.
Trans Faraday Soc., Vol. 55, Pt 5, 842-9 (May, 1959).

Impedance measurements on anodic oxide films give information on the mechanical condition of the film as well as on the dielectric properties of the film material. Microfissures are found to be present in varying severity in different films. Various observations show that with tantalum (and hence possibly with other "valve" metals) microfissures or pores are responsible for electrolytic rectification as normally observed.

537.226.32

6895. X-RAY DIFFRACTION PATTERN OF ELECTRETS.

K.C.Chandy and D.R.Bhawalkar.
J. Univ. Saugar, Part II: Sect. A, Vol. 6, No. 6, 84-9 (1957).

Electrets were prepared from carnauba wax containing no added matter. X-ray diffraction patterns were obtained from: (1) electrets prepared by the usual method; (2) extraneous wax detached from the electret, and (3) wax obtained after remelting the electret. Three types of carnauba wax were used for this purpose: fatty grey, refined fatty grey and prime yellow. Distinct orientations were noticed with electrets prepared from the prime yellow variety, while the other two varieties showed very feeble orientations. Besides the normal rings extra rings were observed in certain patterns, which are assigned to the silica present in the wax.

537.226 33

6896. AN INVESTIGATION OF THE DIELECTRIC RELAXATION EXHIBITED BY GLASS. II. SODA-SILICA AND SODA-LIME-SILICA GLASSES.

H.E.Taylor.
J. Soc. Glass Technol., Vol. 63, 124T-146T (April, 1959).

For Pt I, see Abstr. 2293/1958. Using the methods described in Pt I, a further eleven simple glasses were investigated: five soda-silica glasses having soda contents from 12 to 28 mol. per cent varied so that the effect of the molecular substitution of (a) soda for lime and (b) soda for silica could be examined. The findings of the earlier paper were fully confirmed, and the results on each glass were analysed to give: (a) the magnitude of the dielectric dispersion (b) the activation energy of the relaxation process; and (c) the activation energy of the conduction process. The activation energy corresponding to the relaxation effect was in all cases closely similar to that for the d.c. conductivity, indicating that movement of the alkali ions were responsible for both phenomena. Consideration of the mechanism of such movement through a random network has made it possible to outline a theoretical explanation for the close relationshi between the two phenomena. Examination of the dielectric loss results permitted a graphical estimate to be made of the distribution o relaxation times involved in the relaxation process. This distributic was found to be very closely similar for all the glasses, and it is suggested that it is characteristic of the random vitreous network.

537.226.33

6897. A METHOD FOR OBTAINING DIPOLE MOMENT AND RELAXATION TIME FROM SOLUTION MEASUREMENTS.

D.V.G.L.Narasimha Rao.
J. sci. industr. Res., Vol. 18B, No. 4, 133-7 (April, 1959).

A method is described for the determination of dipole moment and relaxation time from measurements of the dielectric constant and dielectric loss of dilute solutions at two frequencies, on either side of the peak of the absorption curve. The method has been applied to four molecules (chloro-, bromo- and nitrobenzenes and benzophenone) and the derived values of dipole moment and relaxation time have been found to agree with previous literature values; the actual values of tan δ also compare well with previous measurements. It was possible to obtain approximate estimates of the distortion polarization and hence the atom polarization from the same data.

537.226.

6898. DIELECTRIC PROPERTIES OF ICE CRYSTALS.

I. DYNAMIC THEORY OF THE DIELECTRIC CONSTANT.

A.Steinemann and H.Gränicher.
Helv. phys. Acta, Vol. 30, No. 7, 553-80 (1957). In German.

The dielectric properties of crystals obeying a Debye-dispersi are surveyed. Deviations at very low frequencies are due either to a d.c. conductivity or to the appearance of a new dispersion region caused by space-charge effects. The criteria permitting an experimental distinction among the two possibilities are pointed out. An ideal ice crystal having no imperfections in the proton arrangement cannot have a high dielectric constant. One has to assume orientational defects generated by rotation of molecules and ionized stat formed by a proton transfer along the hydrogen bond. Fröhlich's general dynamic theory applied to these imperfections gives the co rect dispersion behaviour. Ionized states lead to a static permittiv of about 25, whereas orientational defects give the observed value c ~ 100 for pure ice and an anisotropy of about 15% due to the hexagonal symmetry. The relaxation time is shown to depend exponentially on the temperature with an activation energy equal to the sum of the energies of formation and diffusion of lattice defects. The theoretical results agree very well with the known dielectric prope ties of H_2O and D_2O crystals. The theory is expanded for substitutions of oxygen by impurity atoms in the lattice which influence the polarization mechanism. In the case of mixed crystals of ice with hydrogen fluoride, it is found that, at sufficiently high HF content, t translational mechanism becomes predominant. In addition there i a contribution to the conductivity which varies as the square root o the fluorine concentration. This leads to a pronounced space-char dispersion for low frequency measurements.

537.226.

6899. DIELECTRIC PROPERTIES OF ICE CRYSTALS.

II. DIELECTRIC INVESTIGATIONS OF ICE CRYSTALS CONTAINI FOREIGN ATOMS.

A.Steinemann.
Helv. phys. Acta, Vol. 30, No. 7, 581-610 (1957). In German.

The dielectric properties of pure ice crystals and ice crystals containing fluorine atoms in the concentration range from 10^{14} to

10^{20} per cm^3 were investigated as a function of frequency, temperature, concentration of fluorine atoms, crystal age and dimensions. Pure ice exhibits at sufficiently high frequencies a Debye-dispersion in agreement with previous results. At very low frequencies a space-charge dispersion is observed. Its permittivity value is correlated to the conductivity caused by incidental impurity atoms. Comparison of all experimental results with theory leads to the following conclusions: In pure ice crystals the Debye-dispersion is caused by rotation of molecules. A proton jumps from a doubly occupied O—O-bond to a normal one. In crystals containing moderate concentrations of fluorine the polarization arised by proton transfer along hydrogen bonds from a H_3O^+-ion to an adjacent H_2O-molecule. At still higher concentrations proton jumps from normal bonds to vacant ones by rotations of molecules prevail. This explains that the static permittivity of the Debye-dispersion falls from ~ 100 to ~ 25 and increases again towards ~ 100 with rising HF content. The activation energy of the relaxation time is 0.575 eV for pure crystals and 0.23 eV for moderately contaminated crystals. At a given temperature the relaxation time varies inversely to the square root of the HF concentration. A combination of both molecular rotation and proton transfer yields a transport of protons over more than one intermolecular distance. This makes a contribution to the a.c. conductivity proportional to the square root of the HF content and with an activation energy of 0.32 eV. It causes a space-charge dispersion whose permittivity varies as the crystal thickness l and reaches values of about 40 000 for $l \cong 1$ cm. The dispersion frequency is proportional to $1/l$ whereas the conductivity does not depend on the geometry.

537.226.8

6900. FACTORS AFFECTING SEPARATIONS OF SUSPENSIONS IN NONUNIFORM ELECTRIC FIELDS. H.A.Pohl and J.P.Schwar.
J. appl. Phys., Vol. 30, No. 1, 69-73 (Jan., 1959).

A study of the more quantitative aspects of the behaviour of suspended polymer particles in a real dielectric is presented. While it is recognized that nonuniform fields exert an attractive force of appreciable magnitude upon particles of high dielectric constant suspended in a liquid medium of lower dielectric constant, the limits of such behaviour are not precisely known. This report presents some quantitative data on the subject. The results show that in real dielectrics there is an appreciable effect due to the very small currents, about 10^{13} amperes at applied voltages in the kilovolt range which even a good liquid insulator supports. It is shown that the initial attraction to the central electrode due to the nonuniform field and its polarizing induction is gradually overcome by the repulsive effects of charge accumulated on the particles resulting from ionic conduction and related events in the liquid. The experimental observations include the study of the effects of field strength, electrode size, cell size and particle size. Field strength, electrode size and particle size show criticality. At certain upper limiting voltages, smaller central electrode diameters and small particle sizes, all precipitation appears to be prohibited. Use of the newly discovered "sluff-off" voltage for making particle size separations is discussed.

537.228.1

6901. β-QUARTZ AS HIGH-TEMPERATURE PIEZOELECTRIC MATERIAL. D.L.White.
J. Acoust. Soc. Amer., Vol. 31, No. 3, 311-14 (March, 1959).

β-quartz, the high-temperature form of quartz, which exists from 573° C to 850° C, is examined for use as a piezoelectric device. The formulae for the piezoelectric constants and elastic constants are given for rotated reference frames. By suitably rotating the crystal plate, it is possible to piezoelectrically excite lengthwise extensional, face shear and thickness shear modes of vibration. Thickness extensional modes cannot be excited. It is thus possible o make both high- and low-frequency piezoelectric resonators and ransducers out of β-quartz for very high temperature applications.

537.228.1

6902. PIEZOELECTRIC RELATIONS AND THE RADIAL DEFORMATION OF A POLARIZED SPHERICAL SHELL.
R.A.Toupin.
J. Acoust. Soc. Amer., Vol. 31, No. 3, 315-18 (March, 1959).

The piezoelectric relations and equations of equilibrium for an elastic spherical shell permanently polarized in the radial direction are derived. The solution for the radial displacement corresponding to uniform pressures on the inner and outer surfaces of the shell and a given voltage difference between the surfaces is obtained.

ELECTRIC CONDUCTION

SEMICONDUCTORS

537.311.1

6903. STATIC SPACE CHARGE AND CAPACITANCE FOR A SINGLE BLOCKING ELECTRODE. J.R.Macdonald.
J. chem. Phys., Vol. 29, No. 6, 1346-58 (Dec., 1958).

Static space-charge distributions in materials having one charge blocking and one ohmic electrode are considered with special emphasis on the situation where charge carriers of only one sign are mobile but which may recombine bimolecularly with fixed charges of opposite sign. The dependence of potential, charge, and electric field on distance from the blocking electrode cannot be obtained exactly in closed form but various simple approximate relations are obtained and are compared with accurate digital computer solutions of the exact relation between potential and distance. Comparison is most significant when the distance scale is normalized by the effective Debye length, a quantity which is shown to depend on recombination ratio when charges of only one sign are mobile. The dependence of total space-charge and differential and static space-charge capacitance on applied potential and recombination is obtained in closed form, and it is shown that recombination can lead to peaks in the curves of static and differential capacitance v. applied potential. Observation of these peaks should afford a simple method of determining recombination ratio and other pertinent parameters of the material. Finally, the addition of a charge-free layer in series with the space-charge region is considered, and the effect of such addition on differential capacitance investigated. The combination of a charge-free layer and space charge region represents a combination of Mott's and Schottky's theories of rectification insofar as capacitance effects are concerned, and is therefore pertinent to measurements on barrier-layer rectifiers as well as to material with a completely blocking electrode.

537.311.1

6904. STATIC SPACE-CHARGE DISTRIBUTIONS WITH A SINGLE MOBILE CHARGE CARRIER. T.M.Proctor and P.M.Sutton.
J. chem. Phys., Vol. 30, No. 1, 212-20 (Jan., 1959).

Static space-charge distributions are found when only one mobile charge carrier exists between plane parallel blocking electrodes. The carriers are assumed to move under diffusion and conduction (Debye–Hückel). Charge dissociation (production) is assumed to be proportional to the combined (bound) charge concentration, which depends on location, where previous two-carrier theory assumes charge dissociation is everywhere a constant. Charge distributions are shown to depend strongly on the recombination rate/dissociation rate ratio and the differences from the symmetric two-carrier cases are discussed. Curves of ln concentration (or voltage) versus distance are given for several applied voltages, recombination rate/dissociation rate ratios, and sample lengths, including the semi-infinite case.

537.311.1 : 539.2

PHYSICAL INTERPRETATION OF MEAN FREE PATH AND THE INTEGRAL METHOD. See Abstr. 6273

537.311.31

6905. ON THE ELECTRICAL CONDUCTIVITY OF METALS.
G.V.Chester and A.Thellung.
Proc. Phys. Soc., Vol. 73, Pt 2, 745-66 (May, 1959).

The exact formula for the electrical conductivity of a metal, derived by Kubo, Greenwood, and others, is evaluated using Van Hove's methods for quantum mechanical transport problems. The evaluation is restricted to the case of elastic scattering by impurities or lattice vibrations, but completely avoids the use of the customary random phase assumption. In the limit of weak coupling the method yields formulae for the conductivity that are identical with those derived from the Boltzmann equation. The accuracy of the weak coupling approximation is investigated and it is found to be accurate as long as $\hbar/\tau \ll \eta$, where τ is the collision time and η is the Fermi energy. A general treatment of the conductivity in an anisotropic metal is given and an explicit expression for the conductivity is written down in terms of the eigenvalues and eigenvectors of an integral equation. A general and rigorous derivation of the conventional Boltzmann equation is given using Van Hove's results on the quantum mechanical master equation.

537.311.32

6906. MEASUREMENT OF THE ELECTRICAL RESISTANCE OF SIZED POWDERS AT DIFFERENT BULK DENSITIES. II. GRAPHITE POWDERS.
T.R.Gopalaswamy, N.R.Subramanian and G.D.Joglekar.
J. sci. industr. Res., Vol. 18A, No. 2, 60-5 (Feb., 1959).

For Pt I, see Abstr. 4568 (1959). Bulk electrical resistivity and bulk density of graphite powders from different sources were determined with a view to establishing criteria for identifying the source of the graphite samples and for determining their suitability for specific industrial purposes. Measurements carried out with 20 samples have shown that bulk electrical resistivity and bulk density of the graphites decrease progressively as the particle becomes more and more flaky. Electrical resistivity increases with increase in the fineness and the ash content of the powders; surface films on the graphite particles also increase the resistivity. Bulk density decreases with increase in the fineness of the powders and increases with increase in ash content.

537.311.32

6907. ELECTRICAL CONDUCTION IN THE ALUMINOSILICATE GLASSES. J.O.Isard.
J. Soc. Glass Technol., Vol. 62, 113T-123T (April, 1959).

Conductivity was measured as a function of temperature for three series of sodium aluminosilicate glasses. The activation energy was found to show a pronounced minimum at composition having one sodium atom to one aluminium atom. It is shown that the activation energy varies inversely as the radius of the shell of oxygen ions surrounding a sodium ion. Hence it is concluded that the size of the oxygen shells increases as AlO_4-tetrahedra are introduced into the network up to the limit Na : Al = 1. Beyond this limit aluminium is assumed to go into six-fold coordination as a network modifier, allowing the coordination shell of the sodium ion to decrease again.

537.311.32 : 621.315.612

6908. THE ELECTRICAL PROPERTIES OF VITREOUS SILICA.
A.E.Owen and R.W.Douglas.
J. Soc. Glass Technol., Vol. 63, 159T-178T (April, 1959).

It is shown that the variation in the d.c. electrical conductivity of various samples of fused silica is related to the impurity content and particularly to the content of sodium. This d.c. conductivity is substantially independent of the water content, but the dielectric properties are shown to be dictated almost entirely by the water content.

537.311.33

6909. SEMICONDUCTOR ABSTRACTS. VOL. IV - 1956 ISSUE.
Edited by E.Paskell.
New York: John Wiley; London: Chapman and Hall (1959) 456 pp.

Compiled by the staff of the Battelle Memorial Institute, Columbus, Ohio. The contents mainly consist of reprinted abstracts from other journals of abstracts. The total number of abstracts is 1462, arranged in a classification scheme based on the names of materials, and subdivided according to their special characteristics. Author and Subject Indexes are also provided.

537.311.33

6910. ON THE THEORY OF STRONG-FIELD CONDUCTION.
P.J.Price.
J. Phys. Chem. Solids, Vol. 8, 136-7 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The conduction problem is formulated in such a way that the drift velocity appears as an eigenvalue of the electron velocity, and this result is discussed. P.T.Landsberg

537.311.33

6911. IMPURITY BAND CONDUCTION IN STRONG MAGNETIC FIELDS. R.J.Sladek.
J. Phys. Chem. Solids, Vol. 8, 515-18 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The mobility μ_i of electrons in magnetically induced impurity bands in n-InSb [see Sladek, J. Phys. Chem. Solids, Vol. 5, No. 3, 157-70 (1958)] is determined as a function of temperature (1.7°-4.2° K) and magnetic field strength B(0-28 000 G) from resistivity and Hall effect measurements. At all temperatures μ_i decreases with increasing B in a manner consistent with μ_i being proportional to an overlap integral between neighbouring donor ions. The temperature dependence of μ_i is discussed in terms of an activation energy. D.M.Edwards

537.311.33 : 539.2

6912. ON THE CONNECTION BETWEEN BONDS AND BANDS IN METALS AND SEMICONDUCTORS.
P.Choquard, A.Janner and E.Ascher.
J. Phys. Chem. Solids, Vol. 8, 366-9, 379-81 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). A theoretical chemical approach to solid-state physics, using the localized electron and valence band models, is outlined. A theorem of Löwdin (Abstr. 7562/1956) is applied to linear chains of hydrogen-like and lithium-like atoms. J.B.Birks

537.311.33

6913. TRANSPORT. C.Herring.
J. Phys. Chem. Solids, Vol. 8, 543-9 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). A stimulating survey of the whole field of transport in semiconductors under four headings: The scattering of free carriers (including comments on scattering mechanisms and negative magneto resistance effects), phonons and excitons (including comments on the anomalous increase of thermal conductivity at high temperatures), quantum transport theory, and hopping mechanisms (in impurity bands and in low-mobility semiconductors). P.T.Landsberg

537.311.33

6914. TRANSPORT PHENOMENA IN SEMICONDUCTORS FOR WARPED ENERGY SURFACES. G.E.Tauber and L.Soffer.
J. Phys. Chem. Solids, Vol. 8, 138-41 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/195 The authors outline a method of discussing transport coefficients in semiconductors on the basis of the Boltzmann equation, using a variational method, and taking into account transitions between bands and the non-spherical nature of the energy surfaces.
P.T.Landsberg

537.311.33

6915. ENERGY TRANSFER IN SEMICONDUCTORS.
M.Balkanski.
J. Phys. Chem. Solids, Vol. 8, 179-81, 193-5 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Comments are made on the theory of the diffusion of excitons in crystals, with special reference to the situation which occurs wher a photon is absorbed with the creation of an exciton, then reemitted, re-absorbed, etc. until it appears at the surface.
P.T.Landsberg

537.311.33

6916. FIELD DEPENDENCE OF MOBILITY IN SEMICONDUCTOR
B.V.Paranjape.
Rep. Brit. Elect. Res. Assoc., Rep. L/T372, 11 pp. (1958).

The present paper applies systematically the idea of "electronic temperature" introduced by Fröhlich (1947) to the calculation of mobility in non-polar crystals. It is shown that Ohm's law is valid in the lowest order up to fields F_c, which produce a drift velocity of the order of the velocity of sound. For $F > F_c$ expressions are derived for field dependent mobilities $\mu(F, T_0)$. It leads to $\mu \alpha F^{-0.5}$ (a) and $\mu \alpha F^{-0.8}$ (b) in two special cases denoted by (a) and (b). It is shown that, for lattice temperatures $T_0 > \theta$ (θ is the Debye temperature), case (a) holds always. If $T_0 < \theta$, however, both the laws shoul be observed, although the range of fields over which the -0.5 law holds may be small. The -0.8 law is in excellent agreement with experimental evidence obtained by Bray (private communication). It is further shown that measurements of mobilities in strong fields at various temperatures permit the details of a check on the interaction of electrons with lattice vibrations. They also permit determination of effective mass m* of carriers over a considerable range

537.311.33 : 621.382

6917. THE MEASUREMENT OF THE TEMPERATURE DEPENDENCE OF THE MOBILITY AND EFFECTIVE LIFETIME OF MINORITY CARRIERS IN THE BASE REGION OF SILICON TRANSISTORS. D.M.Evans.
J. Electronics and Control, Vol. 6, No. 3, 204-8 (March, 1959).

Determined by a method previously described.
The mobility of holes in the n-type base of a fusion-alloy p—n—p junction transistor was found to vary as $T^{-2.1}$. The mobility of electrons in the p-type base of a grown-junction n—p—n transistor was found to vary as $T^{-2.6}$. The value of the effective lifetime of the minority carriers was found in both cases to vary as exp (- ΔE kt) where ΔE was 0.055 eV for the holes in the n-type base, and 0.065 eV for the electrons in the p-type base.

537.311.33

918. AUGER EFFECT IN SEMICONDUCTORS.

'.T.Landsberg and A.R.Beattie.

. Phys. Chem. Solids, Vol. 8, 73-5, 85-6 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/959). Formulae are presented for the life times of excess electrons nd holes as limited by two-particle collisions (Auger effect), both articles being in bands (rather than in localized states). Tempera-ure and concentration dependence of the lifetime are discussed, the ffect being most important when the ratio energy-gap/kT is small.

P.T.Landsberg

537.311.33

919. THE MASS-ACTION LAWS FOR FREE CARRIERS AND MPHOTERIC IMPURITIES IN SEMICONDUCTORS.

F.W.G.Rose.

. Phys. Chem. Solids, Vol. 8, 377-8, 379-81 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 569/1959). The mass action law is used to derive expressions r concentrations of carriers and of various kinds of impurities, r reaction constants and recombination rates. One of the assump-ons made is that an amphoteric impurity can exist in two distinct lectrically neutral states: neutral donor (D^X) and neutral acceptor ^{X}), and that in equilibrium the ratio of their concentrations may e different from unity. The details of this hypothesis are not scussed.

P.T.Landsberg

537.311.33

920. SOME CHARACTERISTICS OF LARGE BAND GAP OMPOUND SEMICONDUCTORS.

J.S.Prener and F.E.Williams.

. Phys. Chem. Solids, Vol. 8, 461-4, 484-5 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 569/1959). Various characteristics due to ionized donor or accep-r impurities in binary compounds such as ZnS are briefly consid-red. These include the charge compensation of the impurities, e association of donors and acceptors, the energy level structures d radiative recombination of associated pairs, metal vacancy-npurity donor pairs, and non-metal vacancy donors in ZnS.

J.B.Birks

537.311.33

921. FINE STRUCTURE IN THE HALL COEFFICIENT.

.C.Beer.

Phys. Chem. Solids, Vol. 8, 507-11, 530 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 69/1959). The Hall coefficient of extrinsic semiconductors such Ge, Si, and AlSb and diamond passes through maxima and minima the magnetic field is varied. A theoretical treatment of this effect s been given and the results are briefly quoted in this paper. A umber of measurements are compared with the theoretical predic-ons. Agreement, on the whole, is good, but in a few cases it appears at the energy surfaces might be more warped than was previously ought.

K.W.Plessner

537.311.33

22. ELECTRON IMPACT IONIZATION IN SEMICONDUCTORS.

Tauc.

. Phys. Chem. Solids, Vol. 8, 219-23, 262-3 (Jan., 1959).

Rochester Semiconductors Conference Paper (see ostr. 4569/1959). Experimental results are presented showing at the quantum yield of the inner photoelectric effect increases if e photon energy exceeds a certain value. This is interpreted as e to the intrinsic electron impact ionization. A theory of this fect is discussed. The relation of the high energy quantum yield the low energy parameters is shown. Some other effects related the intrinsic impact ionization are mentioned.

537.311.33 : 539.2

ELECTRONIC PROCESSES AT GRAIN BOUNDARIES.

e Abstr. 6250

537.311.33

23. CAPACITANCE AND BARRIER HEIGHT IN GRAIN OUNDARIES.

R.K.Mueller.

appl. Phys., Vol. 30, No. 4(1), 546-50 (April, 1959).

It is shown that the capacitance of a grain boundary depends the height of the potential barrier ϕ only if ϕ is smaller than T $\ln(N_d/n_i)$(eV). For higher barrier potentials the capacitance is good approximation a function of the bulk properties only. The pacitance as a function of applied bias and temperature (100°-250° K) as measured on tilt boundaries of 4°, 6°, and 25°, with donor con-ntrations ranging from 10^{14} to 10^{16} per cm^3. It was found that in all cases the barrier height was larger than 2kT $\ln(N_a/n_i)$. This gives for the highest doped samples at 100° K a lower limit for the barrier height of 0.66 (eV).

537.311.33

6924. EFFECT OF THE METAL-TO-SEMICONDUCTOR POTENTIAL ON THE SEMICONDUCTOR SURFACE BARRIER HEIGHT.

N.J.Harrick.

J. Phys. Chem. Solids, Vol. 8, 106-8, 121-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The surface conductivity was measured, by using infrared radiation, as metals (Hg or Ga) were brought into contact with etched germanium surfaces. Changes were observed with relaxation times of the order of 10 sec and are ascribed to changes in the semiconductor surface barrier height and the presence of surface states.

D.J.Oliver

537.311.33 : 539.2

6925. DISLOCATION PLANES IN SEMICONDUCTORS.

H.F.Mataré.

J. appl. Phys., Vol. 30, No. 4(1), 581-9 (April, 1959).

Dislocations and mainly dislocation planes, as the most important nonchemical imperfections in semiconductor crystals, are discussed from the point of view of their influence on carrier transport. After a short review of the general properties of grain boundary planes of medium angle of misfit, the electrical effects are discussed, including the barrier behaviour, the band structure and lifetime anisotropy. Device structures based on these properties of dislocation planes are described among which the dislocation field effect transistor shows promising features as the first temperature independent transistor in the range 300° to 2° K.

537.311.33

6926. SPACE CHARGE IN SEMICONDUCTORS RESULTING FROM LOW LEVEL INJECTION.

M.Green.

J. appl. Phys., Vol. 30, No. 5, 744-7 (May, 1959).

A solution of the continuity equations is obtained for the space charge distribution by assuming (1) that deviations from neutrality are small, and (2) that the space charge fields, which are a consequence of the terms containing $\nabla\cdot E$ in these equations give rise to pure diffusion and pure "drift-wave" terms with time dependent coefficients. It is, for equal numbers of holes and electrons initially injected,

$$e[(p-p_0)-(n-n_0)] = -\tau_\rho \overset{E}{\nabla}\cdot J[1-\exp(-t/\tau_\rho)],$$

where τ_ρ equals $K/4\pi\sigma$, the relaxation time, J is the total current density including diffusion, as well as drift, and $\overset{E}{\nabla}$ means that the divergence does not operate on E (the electric field is held constant). In the differentiation $\partial n/\partial x$ and $\partial p/\partial x$ are considered to be equal, as are $\partial^2 n/\partial x^2$ and $\partial^2 p/\partial x^2$. Working independently, Brooks and van Roosbroeck arrived at expressions for both the ambipolar diffusion coefficient and the "group mobility" of the drift of a pulse of excess carriers. This theory yields the same results, and in addition, transient expressions are obtained for each.

537.311.33

6927. A MANY-BODY TREATMENT OF DIELECTRIC SCREENING FOR IMPURITY STATES AND EXCITONS IN SEMICONDUCTORS.

L.M.Roth and G.W.Pratt, Jr.

J. Phys. Chem. Solids, Vol. 8, 47-49, 50-51 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The problem of a single-donor impurity is treated rigorously using an effective one-electron Hamiltonian. The effective dielectric constant is derived using the perturbation methods of van Hove and Hugenholtz (Abstr. 8429/1957).

D.M.Edwards

537.311.33

6928. SCREENING EFFECTS IN POLAR SEMICONDUCTORS.

H.Ehrenreich.

J. Phys. Chem. Solids, Vol. 8, 130-5 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). A survey is given of the effect of screening by the free carriers on various effects which depend on electron—phonon interactions.

P.T.Landsberg

537.311.33

6929. PROPERTIES OF VARIOUS SEMICONDUCTORS.

A.Joffé.

J. Phys. Chem. Solids, Vol. 8, 6-12, 20 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The emphasis in this review of recent work in Russia

is on the utilization of the high thermoelectric power of semiconductors. The factors governing thermal conductivity are outlined, and measurements of the thermal and electrical conductivities of Bi_2Te_3, In_2Te_3, Te and other compounds are given. There is an interesting discussion on the behaviour of charge carrier mobility in solid solutions of either Sb_2Te_3 or Bi_2S_3 in Bi_2Te_3.
K.W.Plessner

537.311.33 : 536.2.01

6930. THERMAL CONDUCTIVITY IN SEMICONDUCTORS. J.A.Krumhansl.
J. Phys. Chem. Solids, Vol. 8, 343-5, 361-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Refers briefly to the various types of thermal conduction mechanisms and to the division between cases in which thermal excitation requires little energy (important at low temperatures) and those where considerable energy is involved (at high temperatures). Radiation transport is important at high temperatures and in semiconductors can be important at lower temperatures. A brief discussion is given of heat transport by systems in which there is an excitation energy between the ground state and first excited states of the system. S.Weintroub

537.311.33 : 536.212

EXPERIMENTAL STUDIES ON THE THERMAL CONDUCTIVITY IN SEMICONDUCTORS. See Abstr. 6825

537.311.33

6931. THERMAL RESISTANCE DUE TO ISOTOPES AND OTHER POINT DEFECTS. P.G.Klemens.
J. Phys. Chem. Solids, Vol. 8, 345-7, 361-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Discusses the theoretical contributions to the resistivity from boundaries, Umklapp-processes and structural imperfections, and the results of various experimental tests of the theory, including one, not previously reported, of the effect on the resistivity of carbon as substitutional impurity in germanium. S.Weintroub

537.311.33

6932. THEORY OF THERMOELECTRIC AND THERMOMAGNETIC EFFECTS IN NONPOLAR ISOTROPIC SEMICONDUCTORS. J.Appel.
J. Phys. Chem. Solids, Vol. 8, 353-8, 361-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The Boltzmann equations for electrons and phonons have been solved analytically for certain limiting cases, and by numerical methods for certain general cases. The assumptions made include: nondegeneracy, spherical energy surfaces, isotropic relaxation times, neglect of electron—electron scattering. Curves are given (also for some phonon-drag terms). P.T.Landsberg

537.311.33 : 621.315.59

6933. THE FARADAY EFFECT IN ANISOTROPIC SEMICONDUCTORS. I.G.Austin.
J. Electronics and Control, Vol. 6, No. 3, 271-4 (March, 1959).

The theory of the Faraday effect in semiconductors is extended to uniaxial crystals with spheroidal energy surfaces, using the classical Drude—Zener theory. Expressions applicable at infrared frequencies are given and used to discuss preliminary measurements on Bi_2Te_3.

537.311.33

6934. MICROWAVE FARADAY ROTATION: MEASUREMENT OF THE CONDUCTIVITY TENSOR. A.M.Portis.
J. Phys. Chem. Solids, Vol. 8, 326-9, 336-7 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). A microwave bimodal cavity method for the measurement of magnetoconductivity is described. The incident microwaves excite the first mode, which excites currents in the sample. These currents excite the second mode, which is coupled to the detector. With high impedance samples, the sensitivity is 3 to 4 orders higher than with waveguide methods. The theory of the method is developed, and the limits of sensitivity set by the detector noise are discussed. The sensitivity is low compared with direct measurements. A measurement of the mobility of photocarriers in CdS agrees well with published values. Some effects arising from a comparison of low-frequency and microwave measurements are briefly discussed. J.B.Birks

537.311.33 : 538.2

MAGNETIC SUSCEPTIBILITY OF SEMICONDUCTORS. See Abstr. 5874

537.311.333 : 535.345

EFFECT OF PRESSURE ON THE INFRARED ABSORPTION OF SEMICONDUCTORS. See Abstr. 6754

537.311.33

6935. THEORY OF THE ZEEMAN EFFECT IN THE PHOTOIONIZATION OF IMPURITIES. R.F.Wallis and H.J.Bowlden.
J. Phys. Chem. Solids, Vol. 8, 318-20, 336-7 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The quantization of the energies of free electrons or holes into sub-bands or "Landau levels" when a magnetic field is applied to a semiconductor and the infinite densities of states at the edges of the sub-bands lead to the expectation that the photoionization absorption spectrum of impurities in semiconductors should exhibit a series of peaks in an external magnetic field. Some aspects of the theory of this phenomenon, which is called the impurity photo-ionization magneto-optic (IPMO) effect is discussed [see Wallis and Bowlden, J. Phys. Chem. Solids, Vol. 7, No. 1, 78-89 (Oct., 1958)]. Two cases are considered, the low and high field cases. A plot of a theoretical IPMO spectrum for the low field case is shown. The expected peaks are evident if the electric vector of the radiation is perpendicular to the external magnetic field. For the high field case, only the first two peaks are dominant. The IPMO effect can only be observed experimentally at low temperatures sufficient to freeze out the charge carriers at the impurities and provided the effective collision relaxation time is suitable. Also the concentration of the impurities must be small. Some complications that arise such as the association of donor impurities in silicon and germanium with conduction bands which are ellipsoidal rather than parabolic and the degeneracy of the valence bands are mentioned
H.G.Jerrard

537.311.33 : 539.2

6936. BINDING AND SEMICONDUCTOR PROPERTIES OF $A^{III}B^{V}$ COMPOUNDS. O.G.Folberth and H.Welker.
J. Phys. Chem. Solids, Vol. 8, 14-19, 20 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). A model for the interpretation of the characteristic properties of the $A^{III}B^{V}$ compounds is proposed which takes into account the polarization of the valence electrons towards the B^{V} ions. It is supposed that the polarization increases with increasing ionic part of the chemical bond and with increasing mean atomic weight. The influence of polarization on the lattice potential is investigated. It is shown that for $A^{III}B^{V}$ compounds, especially InSb, a neutral binding i to be expected, as proposed by Slater and Koster (Abstr. 8468/1959). The results are used to provide an explanation of the characteristic differences between the values of the energy gap ΔE and the mobility ratio μ_n/μ_p in the various $A^{III}B^{V}$ compounds. Some peculiarities concerning the mutual solubilities of $A^{III}B^{V}$ compounds and the solubilities of elements of Group IV of the Periodic System in $A^{III}B^{V}$ compounds are discussed. It is shown that for a continuous solid solutio to be formed the polarizations must not differ too greatly. This rule allows the preferential formation of continuous solid solutions in the systems InAs—InP and GaAs—GaP to be explained.

537.311.33

6937. SEMICONDUCTORS OF THE TYPE $A^{III}B^{VI}$.
P.Fielding, G.Fischer and E.Mooser.
J. Phys. Chem. Solids, Vol. 8, 434-7, 442-3 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The following compounds were prepared GaSe, GaTe, InSe, InTe, TeSe. Measurements were made of Hall effect and resistivity and also optical absorption and photo response.
D.J.Oliver

537.311.33

6938. INTERMETALLIC SEMICONDUCTORS CONTAINING ALKALI METALS. W.E.Spicer and A.H.Sommer.
J. Phys. Chem. Solids, Vol. 8, 437-9, 442-3 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569 1959). The compounds were formed by reacting Sb or Au films (500 A thick) with alkali metal vapours. For the alkali antimonides M_3Sb values for the band gap and the electron affinity were obtained. The compound AuCs is semiconducting and is possibly ionic.
D.J.Oliver

537.311.33

6939. ELECTRONIC PROCESSES IN THE SILVER HALIDES AT LOW TEMPERATURE. F.C.Brown and K.Kobayashi.
J. Phys. Chem. Solids, Vol. 8, 300-1, 302-4 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The influence of multiple trapping effects on the low-temperature electron drift mobility is discussed. B.T.M.Willi

537.311.33

40. PHOTOCONDUCTIVITY IN CRYSTALS OF SILVER
OMIDE. E.A.Braun and J.W.Mitchell.

Phys. Chem. Solids, Vol. 8, 297-300, 302-4 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr.
59/1959). Measurements were made of the photoconductivity of
Br crystals at temperatures between -183° and -78°C, irradiated
h light of wavelength 436 mμ. Crystals of high purity and perfec-
n had low photochemical sensitivity, the range of conduction
ctrons was 3×10^{-6} cm^{2} V^{-1}. The range increased to 10^{-4} cm^{2}
^{1} in crystals sensitized with silver oxide. Sensitization introduces
ps for positive holes at which recombination does not occur.
J.Franks

537.311.33

41. THERMO-MAGNETIC PHENOMENA IN SILVER TELLU-
DE. V.P.Zhuze, I.M.Tsidil'kovskiĭ and T.S.Bartnitskaya.

. tekh. Fiz., Vol. 28, No. 8, 1646-50 (1958). In Russian.
Measurements were made (120°-600° K) on the longitudinal and
nsverse Nernst—Ettinghausen fields, the thermoelectric forces,
ll constants, and conductivities of Ag$_2$Te and AgTe. The results
e analysed in several temperature intervals. Earlier suppositions
t the bonding in Ag$_2$Te changes from covalent-metallic to ionic in
phase change at 150° C are confirmed; the bonding in AgTe was
ic throughout the temperature range used. K.F.Hulme

537.311.33 : 538.27

42. NUCLEAR MAGNETIC RESONANCE IN SEMICONDUCTORS
Kraus.

Phys. Chem. Solids, Vol. 8, 504-5, 506 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr. 4569/
59). Exploratory measurements of spin-lattice relaxation times in
olycrystalline specimens of p-type and one of n-type AlSb between
$^{\circ}$ and 298°K are reported. The results are discussed briefly with
erence to possible relaxation processes. A.J.Manuel

537.311.33

43. ON THE HALL EFFECT IN BISMUTH.
A.Coldwell-Horsfall and D.ter Haar.

ysica, Vol. 24, No. 10, 848-54 (Oct., 1958).
The results of a previous paper (Abstr. 3453/1958) are used to
aluate the Hall coefficient of bismuth at liquid helium temperatures,
ing a generalization of Dingle's expression for the Fermi level as
unction of the magnetic field strength and Shoenberg's parameters
the energy surfaces. The oscillatory part of the Hall coefficient
satisfactorily reproduced, but the theory predicts a linear beha-
ur of the non-oscillatory part, while a quadratic dependence is
nd experimentally. Including the contribution to the conductivity
to holes changes the field dependence of the steady part of the
ll coefficient from H to H$^{1.3}$, and does not significantly alter the
solute magnitude or the oscillatory part.

537.311.33

44. GALVANOMAGNETIC EFFECTS IN BISMUTH TELLURIDE.
.Drabble.

Phys. Chem. Solids, Vol. 8, 428-30, 442-3 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr.
59/1959). If the electric field E is expressed as a function of the
rrent density J and the magnetic induction B by the relation

$$E_i = \rho_{ij}J_j - \rho_{ijk}J_jB_k + \rho_{ijkl}J_jB_kB_l$$

n in Bi$_2$Te$_3$ the number of independent components of ρ_{ij} is 2,
$_k$ is 2 and ρ_{ijkl} is 8. Measurements at liquid nitrogen tempera-
e have yielded seven coefficients for n-type material and nine
p-type material. Values of the principal effective masses within
alley are tabulated and for p-type material the density of states
ective mass was found to be 0.51 m$_0$. The conductivity mobility
the cleavage planes at room temperature was 1200 cm^{2} (V sec)$^{-1}$
electrons and 500 cm^{2} (V sec)$^{-1}$ for holes. D.J.Oliver

537.311.33

45. TRANSPORT PROPERTIES OF THE PSEUDO-BINARY
LOY SYSTEM Bi$_2$Te$_{3-y}$ Se$_y$.
Fuschillo, J.N.Bierly and F.J.Donahoe.

Phys. Chem. Solids, Vol. 8, 430-3, 442-3 (Jan., 1959).
Rochester Semiconductors Conference Paper (see Abstr.
59/1959). Measurements have been made of the electrical
nductivity, the Seebeck coefficient and the room temperature
rmal conductivity. The transport properties show anomalous
haviour at y = 0.9 where an anomaly in the optical band gap had been previously observed. An explanation for the latter is put forward but the occurrence of the anomalies in transport properties at the same composition seems fortuitous. D.J.Oliver

537.311.33

6946. METALLIC CONDUCTION IN THE CRYSTAL COMPOUNDS OF GRAPHITE. A.R.Ubbelohde, L.C.F.Blackman and J.F.Mathews.

Nature (London), Vol. 183, 454-6 (Feb. 14, 1959).

The anisotropic conductance of electrons parallel to the a- and c-axes of graphite, and its change when crystal compounds of potassium, bromine and iodine monochloride are formed with graphite, were studied. The a-axes of crystallites in columnar graphite and the a- and c-axes in pyrolytic graphite are well aligned: the absence of serious crystal defects in the specimens was further confirmed by the measured temperature coefficients of resistance. Formation of crystal compounds gave marked decreases in resistance parallel to a-axes in accord with previous views that the conduction bands of aromatic macromolecules accept electrons from the potassium and probably donate electrons to the bromine. In directions parallel to c-axes the large decreases in resistance with the addition of potassium are consistent with the view that quasi-metallic bonds between the potassium and the aromatic macromolecules are formed; this result is confirmed by an increase in the positive coefficient of temperature. The smaller decrease in resistance with the addition of bromine and iodine monochloride is related tentatively to their different crystal structure. G.C.Williams

537.311.33

6947. CYCLOTRON RESONANCE IN CADMIUM SULFIDE.
R.N.Dexter.

J. Phys. Chem. Solids, Vol. 8, 494-5, 506 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Measurements between 1.2° and 4.2°K using linearly polarized microwaves indicate that infrared illumination (2-3 μ) produces carriers preferentially with effective masses of about 0.07m$_0$ with slight anisotropy. Visible light produces in addition, and more abundantly, carriers on two energy surfaces, with average effective masses of about 0.36m$_0$ and 0.14m$_0$. A.J.Manuel

537.311.33 : 535.343

6948. INFRARED ABSORPTION AND ELECTRON EFFECTIVE MASS IN N-TYPE GALLIUM ARSENIDE.
W.G.Spitzer and J.M.Whelan.

Phys. Rev., Vol. 114, No. 1, 59-63 (April 1, 1959).

The infrared absorption between 0.85 and 25 μ was measured as a function of carrier concentration for n-type single-crystal gallium arsenide. The absorption in the 1 to 5 μ region is compatible with a model in which there are minima ~ 0.25 eV above the bottom of the conduction band. Infrared reflectivity measurements on several samples of different carrier concentrations were used to deduce the free carrier contribution to the electric susceptibility and the electron effective mass. The results indicate a value for the mass of (0.078 ± 0.004)m with an indication of an increase for the sample of highest carrier concentration. This value is substantially larger than previously reported values.

537.311.33

6949. THE EFFECT OF THE IRRADIATION OF GERMANIUM WITH α-PARTICLES ON THE RECOMBINATION OF CURRENT CARRIERS. G.Dorda.

Czech. J. Phys., Vol. 8, No. 2, 181-5 (1958).

A study was made of the effect of irradiation with α-particles on surface recombination on germanium. An approximative evaluation of the results showed that the position of the energy level of the recombination centre produced by irradiation lies near to the upper edge of the valence band, or the lower edge of the conduction band. A value of about 3×10^{-12} cm^{2} was obtained for the effective recombination surface produced by the absorption of one α-particle.

537.311.33

6950. RECOMBINATION CENTERS ON ION-BOMBARDED AND VACUUM HEAT-TREATED GERMANIUM SURFACES.
S.Wang and G.Wallis.

J. appl. Phys., Vol. 30, No. 3, 285-90 (March, 1959).

Germanium surfaces were bombarded with argon ions and then heat-treated under high vacuum. Room-temperature values of surface recombination velocity, surface conductivity, dark field effect, and field effect under illumination were measured after successive heat treatments. In addition, the temperature dependence of these quantities was determined. It was confirmed that after annealing of the bombardment damage, a large number of acceptor type surface

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states approximately clamped the surface potential. Two types of recombination centres were identified: type 1, located near the middle of the gap and type 2, located near the valence band. The various heat treatments produced changes in the density of the type 1 centres but did not appear to effect the density of type 2 centres.

537.311.33

6951. CONTACT POTENTIAL MEASUREMENTS ON CLEANED GERMANIUM SURFACES. A.B.Fowler.

J. appl. Phys., Vol. 30, No. 4(1), 556-8 (April, 1959).

The contact potential of the (110) face of the n and p regions of an n-p germanium crystal was measured in a vacuum of less than 10^{-9} mm Hg using a Kelvin bridge technique. The n and p regions were so doped that their resistivities were 0.058 and 0.033 ohm cm, respectively. If there had been no surface states the difference in work function would have been 0.34 eV. The argon-cleaned surface exhibited a difference of 0.002(± 0.004) eV. An exposure of as little as 0.4×10^{-7} mm min of oxygen increased the difference to 0.013 eV. A difference as large as 0.018 eV was observed after a 28×10^{-7} mm min exposure. After 56×10^{-7} mm min the difference was reduced to 0.000(± 0.005) eV. These results are discussed in terms of several surface state distributions.

537.311.33

6952. RADIATIVE RECOMBINATION AND LIFETIME IN GERMANIUM. P.H.Brill and R.F.Schwarz.

J. Phys. Chem. Solids, Vol. 8, 75-7, 85-6 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Experiments were carried out to measure the recombination radiation resulting from a known concentration of excess carriers and thus to check the theory of van Roosbroek and Shockley (Abstr. 8281/1954). The agreement was satisfactory. D.J.Oliver

537.311.33

6953. CARRIER RECOMBINATION IN GERMANIUM AS A FUNCTION OF TEMPERATURE BETWEEN 100°K AND 550°K. S.Goldstein, H.Mette and W.W.Gärtner.

J. Phys. Chem. Solids, Vol. 8, 78-80, 85-6 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Measurements of lifetime were made using the photomagnetoelectric effect (PME). The results for p-type samples are in agreement with the Shockley—Read theory (Abstr. 8183/1952). The results for n-type samples were not always reproducible. D.J.Oliver

537.311.33

6954. EFFECT OF ANNEALING ON THE STATE OF CERTAIN IMPURITIES IN Ge.

V.E.Lashkarev, E.G.Miselyuk and K.D.Glinchuk.

J. Phys. Chem. Solids, Vol. 8, 84, 85-6 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Specimens containing iron, nickel and cobalt showed a decrease in carrier concentration with decreasing temperature, and a lifetime less than a μsec. Annealing at 500°C caused a large increase in lifetime, and the carrier concentration was then temperature-independent from 100° - 350°K. During annealing the acceptor levels become deactivated by the release of the impurities from the solid solution. C.Hilsum

537.311.33

6955. THE EFFECT OF SOME SURFACE TREATMENTS ON THE CHARACTERISTICS OF FAST STATES ON GERMANIUM SURFACES. E.Harnik and Y.Margoninski.

J. Phys. Chem. Solids, Vol. 8, 96-9, 121-2 (Jan., 1959).

Rochester Semiconductors Conference paper (see Abstr. 4569/1959). The effect of treatment on surface recombination velocity, the ratio of the capture probability for electrons and holes and the density of recombination centres was determined. D.J.Oliver

537.311.33

6956. OPTICAL AND MAGNETIC SURFACE STUDIES ON GERMANIUM. R.Bray and R.W.Cunningham.

J. Phys. Chem. Solids, Vol. 8, 99-102, 121-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The Hall mobility and magnetoresistance were measured as a function of the change in sample conductance due to surface conduction. Also the spectral dependence of the photoconductivity due to the slow surface states was measured. These results are discussed in terms of a model for the surface states. D.J.Oliver

537.311.33

6957. MAGNETO-SURFACE PROPERTIES OF NEAR INTRINSIC GERMANIUM. J.N.Zemel and R.L.Petritz.

J. Phys. Chem. Solids, Vol. 8, 102-5, 121-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). A continuation of earlier work (Abstr. 4955/1958), studying in more detail the importance of light holes in surface charge transport, and the surface mobility. Measurements were made of Hall coefficient and magneto-resistance of a specimen 27 microns thick while the surface was subject to a modified Bardeen—Brattain cycle. The comparison of theory and experiment confirms the existence of a diffuse surface scattering mechanism. C.Hilsum

537.311.33

6958. HALL MOBILITY OF A CLEANED GERMANIUM SURFACE. R.Missman and P.Handler.

J. Phys. Chem. Solids, Vol. 8, 109-11, 121-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). A 20 ohm cm n-type sample 0.2 mm thick was cleaned by argon ion bombardment and annealed in a vacuum of better than 10^{-9} mm Hg. The Hall coefficient and resistivity were measured as oxygen was admitted into the system, and the results interpreted in terms of changes in hole concentration in the surface region. The variations in surface mobility were consistent with a model of diffuse scattering at the surface. C.Hilsum

537.311.33

6959. ELECTRICAL PROPERTIES OF CLEAN GERMANIUM SURFACES. G.A.Barnes and P.C.Banbury.

J. Phys. Chem. Solids, Vol. 8, 111-13, 121-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Measurements of the field effect on conductance and of the photoconductance have been made on germanium surfaces freshly cleaved in a vacuum of 10^{-10} mm Hg. Values of the surface recombination velocity on clean n-type surfaces were between 100 and 300 cm sec^{-1} and these values increased by a factor of 6 on exposing to air. Experiments on intrinsic material were also carried out. D.J.Oliver

537.311.33

6960. THE MOBILITY, DIFFUSION CONSTANT, AND LIFETIME OF MINORITY CARRIERS IN HEAVILY DISLOCATED GERMANIUM. A.F.Gibson.

J. Phys. Chem. Solids, Vol. 8, 147-9, 164-5 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The object of the work was to discover whether the diffusion constant D is isotropic. Light spot experiments showed that in n-type material the value of D parallel to the dislocation array was 2-3 times greater than D measured perpendicular to the array. No comparable effect was found for p-type material. Drift mobility measurement showed the mobility in n-type material to be isotropic. At high electric fields some anisotropy in the drift mobility for holes was discovered. The significance of these results is discussed. D.J.Oliver

537.311.33

6961. CHEMICAL SHIFT OF DONOR STATES IN GERMANIUM. G.Weinreich.

J. Phys. Chem. Solids, Vol. 8, 216-17, 218 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Effective-mass calculations are made of the impurity levels in germanium, taking into account the local shear strain produced by the impurity atoms. The relative positions of the levels are predicted correctly for the pairs antimony—phosphorus and antimony—arsenic but not for arsenic—phosphorus. This failure with arsenic—phosphorus may represent a breakdown of the effective-mass approximation. B.T.M.Willis

537.311.33

6962. EFFECT OF ELECTRON AND IMPURITY DENSITY ON THE FIELD-DEPENDENCE OF MOBILITY IN GERMANIUM. J.B.Gunn.

J. Phys. Chem. Solids, Vol. 8, 239-41, 262-3 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Previous experiments showed that the rate of energy transfer between electrons and lattice required to account for the dependence on the field E of the mobility μ observed in germanium at low temperature is greater than can be caused by the interaction of acoustic phonons with electrons of thermal energy. The possibili is here examined that electron—electron (e—e) collisions may enhance the probability of emission of optical phonons, by measuring he dependence of μ on E at different impurity concentrations. This llowed also observation of the effect of impurity scattering. Com- lete interpretation of the results is impossible, due to inadequacy f existing theories, but it appears that e—e scattering does con- ribute to the energy dissipation rate. Further remarks by Morgan n the discussion. L.Pincherle

537.311.33

963. THE MOBILITY OF ELECTRONS HEATED BY MICRO- VAVE FIELDS IN N-TYPE GERMANIUM. T.N.Morgan.
. Phys. Chem. Solids, Vol. 8, 245-9, 262-3 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 569/1959). The deviation of electron energy distribution from the ero field Maxwellian distribution due to the application of a field is alculated, numerical values being obtained by electronic computer. he calculation is extended to the case of very high frequency fields, ince the superposition of d.c. and microwave fields is a convenient xperimental method of checking the results. Reasonable agreement ith theory in the dependence of conductivity on field was found. K.W.Plessner

537.311.33

964. FAR INFRARED MAGNETO-OPTIC EFFECTS FROM MPURITIES IN GERMANIUM. W.S.Boyle.
. Phys. Chem. Solids, Vol. 8, 321-3, 336-7 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 569/1959). The effect of a magnetic field on excited impurity tates (donors) in germanium at liquid helium temperatures is tudied. Zeemann splitting of excited state levels is observed and n effective mass (0.08 m) obtained which agrees with that calculated rom cyclotron resonance. The magnetic field causes conduction evels to form Landau sub-bands and an oscillation in absorption oefficient with increasing magnetic field is observed. From the vell resolved changes at high field strengths precise values of ffective mass can be obtained. G.F.J.Garlick

537.311.33

965. MICROWAVE HALL EFFECT IN GERMANIUM AND SILICON AT 20 kMc/s. G.E. Hambleton and W.W.Gärtner.
. Phys. Chem. Solids, Vol. 8, 329-32, 336-7 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 569/1959). Measurements of Hall mobility were made between 30° and 500°K and at fields between 0 and 10^4 Oe. The results for ilicon indicate no deviation from the low frequency values. Signifi- cant reductions were found for germanium. The work is to be ex- ended. D.J.Oliver

537.311.33 : 539.2

966. ENERGY BANDS OF SILICON AND GERMANIUM. .C.Phillips.
. Phys. Chem. Solids, Vol. 8, 369-71, 379-81 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 569/1959). The shapes of the energy bands in silicon and germanium rystals were calculated, using an interpolation scheme based on he plane-wave formalism with the orthogonalization terms replaced y a repulsive pseudopotential. The basic assumption is that the ore has little effect on the variation of energy with wave vector or bands near the energy gap. The results agree well with the xperimental data. J.B.Birks

537.311.33 : 539.2

967. BAND STRUCTURE CALCULATIONS OF SEMICONDUCT- RS BY THE KOHN—ROSTOKER—KORRINGA METHOD: PPLICATION TO GERMANIUM. B.Segall.
. Phys. Chem. Solids, Vol. 8, 371-4, 379-81 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 569/1959). Results are given of eigenvalue computations for (a) he deep, well-separated spherical well model, (b) the shallow pherical well model, and (c) the germanium crystal. J.B.Birks

537.311.33

968. PRESSURE-DEPENDENCE OF THE RESISTIVITY OF ERMANIUM.
.Michels, J. Van Eck, S.Machlup and C.A.Ten Seldam.
. Phys. Chem. Solids, Vol. 10, No. 1, 12-18 (April, 1959).

The effect of hydrostatic pressure on the resistance of a p-type ample of germanium (specific resistivity about 80 ohm cm at 293°K) vas investigated up to 2700 atm at temperatures between +125° and -150°C. The results in the intrinsic range indicate an increase in he energy gap of 5.4×10^{6} eV/atm, in agreement with earlier xperimental determinations. In the extrinsic region the resistivity lecreases slightly with pressure, indicating an increase in hole nobility of 9 p.p.m./atm.

537.311.33 : 534.23

6969. ACOUSTOELECTRIC EFFECT IN N-TYPE GERMANIUM. G.Weinreich, T.M.Sanders, Jr and H.G.White.
Phys. Rev., Vol. 114, No. 1, 33-44 (April 1, 1959).

Theory and experiment are presented for the drag exerted on electrons in a solid by a travelling ultrasonic wave. After a discussion of the reasons why the effect is generally very small, it is shown that under certain conditions in n-type germanium it may be quite appreciable, and that its size directly indicates the intervalley scattering rate. Experimental data are given for arsenic-doped germanium ranging in impurity content from 10^{14} to 10^{16} cm^{-3}, at temperatures from 20° to 160°K. These yield the absolute value of the "uniaxial" deformation potential constant (16 eV) and the intervalley scattering rate as a function of temperature and doping. The interpretation of the results ascribes intervalley scattering action both to phonons and to impurities. The phonon contribution yields the frequency on the $\langle 100 \rangle$ longitudinal phonon (6.6×10^{12} sec^{-1}) and the size of the appropriate coupling parameter; the impurity contribution yields intervalley scattering cross-sections for neutral and ionized donors as a function of temperature. The two cross-sections are explained as, respectively, being due to exchange scattering events and to compound capture—re-emission processes. Further analysis gives a lower limit to the valley—orbit splitting of the arsenic donor ground state (1.7×10^{-3} eV). The experiment verifies that the conduction-band valleys lie on $\langle 111 \rangle$ axes at the Brillouin zone edge. Ultrasonic attenuation due to intervalley scattering is discussed and is shown to be too small to be easily measurable.

537.311.33 : 535.343

6970. EXCITON AND MAGNETO-ABSORPTION OF THE DIRECT AND INDIRECT TRANSITIONS IN GERMANIUM.
S.Zwerdling, B.Lax, L.M.Roth and K.J.Button.
Phys. Rev., Vol. 114, No. 1, 80-9 (April 1, 1959).

Low-temperature, high resolution experiments on magneto-absorption effects in germanium have resolved fine structure in the direct interband transition and, in addition, have revealed structure in the indirect transition. In each case, exciton absorption was also observed and the experimental binding energy of the lowest exciton level was measured. The values of the direct-transition energy gap found were (1) at 1.5° and 4.2°K, 0.898 ± 0.001 eV; (2) at 77°K, 0.889 ± 0.001 eV; and (3) at 293°K, 0.805 ± 0.001 eV. The binding energy of the "direct" exciton was 0.0025 ± 0.0005 eV. The magneto-absorption at photon energies slightly greater than the indirect energy gap has the appearance of a series of absorption edges unlike the series of absorption maxima observed in the direct case. The experimental findings are consistent with theoretical predictions (see following abstract). The detailed spectra were observed by means of a new low-temperature, high-resolution magneto-spectrophotometric system providing spectral resolution of the order of 10^{-4} eV and steady magnetic fields up to 38.9 kilogauss. An accurate measure of the minimum of the conduction band was obtained by extrapolating a plot of the photon energies of the centres of the absorption edges as a function of magnetic field to zero field. The indirect energy gap, 0.744 ± 0.001 eV at 1.5°K, was then obtained by subtracting the energy of the emitted longitudinal acoustical phonon which is involved in the indirect transition. This accurate value of the energy gap permits the measurement of the exciton binding energy. The "indirect" exciton ground state was found to be split into two components 0.0011 eV apart with a mean value of the binding energy of 0.0025 ± 0.0004 eV. These values are consistent with preliminary theoretical calculations. The Zeeman effect of both the direct and indirect exciton absorptions has also been measured and found to be quadratic in accordance with theory.

537.311.33 : 539.2

DEEP LEVEL IMPURITIES IN GERMANIUM. See Abstr. 6271

537.311.33 : 539.2

HIGH-VACUUM STUDIES OF SURFACE RECOMBINATION VELOCITY FOR GERMANIUM. See Abstr. 6274

537.311.33 : 536.212

THERMAL CONDUCTIVITY OF GERMANIUM IN THE TEMPERATURE RANGE 300°-1080°K. See Abstr. 6826

537.311.33 : 535.343

6971. THEORY OF OPTICAL MAGNETO-ABSORPTION EFFECTS IN SEMICONDUCTORS. L.M.Roth, B.Lax and S.Zwerdling.
Phys. Rev., Vol. 114, No. 1, 90-104 (April 1, 1959).

See also preceding abstract. The theory of the effect of a magnetic field on the optical absorption in semiconductors is developed on the basis of the effective-mass approximation. For simple parabolic conduction and valence bands and a direct transition which is allowed at $k = 0$, absorption peaks occur at energies above the zero-field gap. Since the selection rule for the transition $\Delta n = 0$ where n is the magnetic quantum number, the spacing between the peaks is the sum of the cyclotron frequencies for the two bands. For degenerate band edges, the spectrum is more complicated. A detailed treatment of the direct transition in germanium is given in which account is taken of the change in curvature of the bands away from $k = 0$ and the results are in good agreement with the experimental measurements of Zwerdling, Lax, Roth, and Button. The $k = 0$ conduction band mass is found to agree with predictions based on cyclotron resonance in the valence band. In addition, a gyromagnetic ratio for conduction electrons of -2.6 resulted from the calculations. The deviation from $g = 2.0$ is due to spin-orbit interaction. In InSb the effect is much greater, the result being $g = -50$. These are consistent with experimental results. For bands in which the transition probability vanishes at $k = 0$, absorption peaks will also occur corresponding to $\Delta n = \pm 1$ but absorption edges occur for $\Delta n = 0$. In the case of indirect transitions, the absorption does not exhibit oscillations but consists of a series of "steps" as has been observed in Ge by Zwerdling, Lax, Roth, and Button.

537.311.33

6972. DISTRIBUTION COEFFICIENTS AND CARRIER MOBILITIES IN InSb. A.J.Strauss.

J. appl. Phys., Vol. 30, No. 4(1), 559-63 (April, 1959).

The following distribution coefficients were measured for InSb crystals pulled from the melt at an extraction rate of 1.3 cm/hr and rotation rate of 130 r.p.m.: Cd, 0.26; Zn, 3.38; Se, 0.17; Te, 0.54. The distribution coefficient for zinc was found to vary with extraction and rotation rates in the manner predicted by the theory of Burton, Prim, and Slichter. Hall mobilities at 77°K were measured for uncompensated samples containing impurity concentrations between 10^{15} and 10^{19} cm^{-3}. Mobilities calculated from scattering theory are in moderately good agreement with the experimental values for n-type samples, but the agreement is considerably less satisfactory for p-type samples.

537.311.33

6973. EFFECT OF HEAT TREATMENT UPON THE ELECTRICAL PROPERTIES OF INDIUM ARSENIDE. J.R.Dixon and D.P.Enright.

J. appl. Phys., Vol. 30, No. 5, 753-9 (May, 1959).

Large reversible variations in carrier concentration, Hall mobility, and carrier lifetime were produced in indium arsenide by heat treatment. For material cut from the parent ingot, carrier lifetimes measured by the photoelectromagnetic—photoconductive ratio method increase by a factor of over 20 as a result of slow cooling from 850°C. Heat treatment at temperatures of 450°C and above increases the carrier concentration of n-type material and decreases the carrier concentration of p-type material. Such variations are reversed by heat treatment at temperatures below 350°C. In this way, changes in the carrier concentration of over 10^{17} cm^{-3} were produced, and InAs was converted from p- to n-type. Various heat treatment mechanisms are examined. It is shown that the experimental results are consistent with the model proposed by Kurtz and Kulin involving the segregation and dispersion of donor impurities to and from dislocations.

537.311.33

6974. HIGH ELECTRIC FIELD EFFECTS IN N-INDIUM ANTIMONIDE. M.C.Steele and M.Glicksman.

J. Phys. Chem. Solids, Vol. 8, 242-4, 262-3 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). At 77°K with fields above 200 volts/cm, electron-hole pairs are created by impact ionization. As a result for further small increases in field, the Hall coefficient decreases and the current increases rapidly. The effects are studied as functions of both transverse and longitudinal magnetic fields. C.Hilsum

537.311.33

6975. THE INFRARED FARADAY EFFECT DUE TO FREE CARRIERS IN INDIUM ANTIMONIDE.

T.S.Moss, S.D.Smith and K.W.Taylor.

J. Phys. Chem. Solids, Vol. 8, 323-6, 336-7 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). From the rotation of the plane of polarization of radiation (10-20μ) passing through an indium antimonide specimen the effective mass can be deduced in two different ways. The ratio of rotation per unit field to absorption coefficient gives the carrier mobility. G.F.J.Garlick

537.311.33

6976. ON TRANSPORT EFFECTS IN INDIUM ANTIMONIDE.

M.Rodot.

J. Phys. Chem. Solids, Vol. 8, 358-60, 361-2 (Jan., 1959). In French.

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Assuming the existence of a single time of relaxation τ, the effect of the energy dependence of τ on some of the transport coefficients (notably the Nernst coefficient) is investigated. P.T.Landsberg

537.311.33

6977. GALVOMAGNETIC EFFECTS IN n-InSb AT LOW TEMPERATURES IN STRONG MAGNETIC FIELDS.

J.C.Haslett and W.F.Love.

J. Phys. Chem. Solids, Vol. 8, 518-23, 530 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The electric field needed to cause impact ionization at 4°K increased with the applied magnetic field. Breakdown occurred at 0.8 volt/cm with a field of 29 000 gauss, and at 3 volt/cm with 163 000 gauss applied. Hall coefficient and magnetoresistance were also measured. C.Hilsum

537.311.33

6978. IMPURITY COMPENSATION AND MAGNETORESISTANCE IN p-TYPE SILICON. D.Long, C.D.Motchenbacher and J.Myers.

J. appl. Phys., Vol. 30, No. 3, 353-62 (March, 1959).

A new method is proposed for determining the separate concentrations of acceptor and donor impurities in crystals of p-type silicon, and thereby the degree of compensation of acceptors by donors. The method involves finding the total concentration of impurities in a sample from a measurement of the weak-field transverse magnetoresistance at 77°K and combining this result with the excess of acceptors over donors determined from a room-temperature resistivity or Hall effect measurement. An empirical "master curve" of magnetoresistance versus impurity density has been constructed for this purpose. The impurity densities for the master curve were measured by the usual method of fitting a theoretical carrier concentration versus temperature equation to an experimental curve obtained from Hall effect data.

537.311.33

6979. SULFUR IN SILICON.

R.O.Carlson, R.N.Hall and E.M.Pell.

J. Phys. Chem. Solids, Vol. 8, 81-3, 85-6 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Sulphur was introduced by diffusion or by growing crystals in a hydrogen sulphide atmosphere. It gave two donor levels, at 0.18 eV and 0.37 eV from the conduction band. Up to 3×10^{16} cm^{-3} sulphur atoms could be dissolved, and retrograde solid solubility was observed. The diffusion coefficient was 10^{-7} cm^2/sec at 1300°C with an activation energy of 2.2 eV. Photoconductive spectra confirmed the energy level scheme determined electrically. It is suggested that sulphur is a substitutional impurity which diffuses interstitially. C.Hilsum

537.311.33

6980. WORK FUNCTION AND EMISSION STUDIES ON CLEAN SILICON SURFACES. F.G.Allen.

J. Phys. Chem. Solids, Vol. 8, 119-20, 121-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Reports measurements on clean Si tips using (a) field emission microscope, (b) Kelvin contact potential method, (c) thermionic emission. The origin of the field emission electrons is not yet clear and the thermionic work function, which has a strong positive temperature coefficient at high temperatures, does not match the low temperature values. Drastic changes in ϕ in the region 300°-1300°K have not, however, been directly observed. A.H.W.Bec

537.311.33 : 538.27

R.F. ORIENTATION OF Sb^{122} DONORS IN DOPED Si. See Abstr. 5923

537.311.33 : 539.2

STATE DENSITY IN THE VALENCE BAND OF SILICON. See Abstr. 6239

537.311.33

6981. LOW TEMPERATURE IMPURITY CONDUCTION IN SILICON. T.A.Longo, R.K.Ray and K.Lark-Horovitz.

J. Phys. Chem. Solids, Vol. 8, 259-61, 262-3 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The behaviour of the resistivity at 14.2°K plotted again concentration of majority carriers N can be broken into three separate ranges. (1) For $N < 10^{18}$ cm^{-3} the conductivity increases with increasing N and the conduction process is presumably a charge exchange between randomly distributed impurities. (2) For $N > 5\ 10^{18}$ cm^{-3} the conductivity is almost constant and conduction is believed to take place in an impurity band. (3) In the intermediate range there is a sharp drop in resistivity, attributed by James to onset of conduction along preferred paths. The effect of impurity compensation introduced by 10 MeV deuteron irradiation is described. The relation of these results with Mott's model (Abstr. 9174/1957) was the subject of the discussion. L.Pincherle

537.311.33

6982. ELECTRONIC PROPERTIES OF GRAY TIN SINGLE CRYSTALS. A.W.Ewald and O.N.Tufte.

J. Phys. Chem. Solids, Vol. 8, 523-5, 530 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Crystals grown from mercury solution contained about 10^{17} donors per cm^3. The conductivity, Hall coefficient and magnetoresistance of a typical specimen were measured at 78° and 4.2°K, and compared with results of similar measurements on a filament obtained by phase transformation. The carrier concentrations were similar, but the crystal grown from the solution had a higher mobility, indicating that its crystal structure was more perfect. C.Hilsum

537.311.33

6983. AN APPROACH TO INTRINSIC ZINC OXIDE.

W.Ruppel, H.J.Gerritsen and A.Rose.

Helv. phys. Acta, Vol. 30, No. 6, 495-503 (1957).

The resistivity of layers of finely divided zinc oxide powder approaches about 10 powers of ten closer to intrinsic zinc oxide than do single crystals. The electrical properties of these layers can be analysed as if the material were homogeneous. These properties include the formation of depletion layers and the large rectifying action obtained with ohmic and blocking contacts. The finely divided state appears here mainly to allow surface adsorbed oxygen to simulate the effects it would have if it could be diffused into the volume of the bulk material.

537.311.33

6984. CONDUCTING STATES IN ORGANIC MOLECULAR CRYSTALS. D.Fox.

J. Phys. Chem. Solids, Vol. 8, 439-41, 442-3 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Describes briefly a method of calculating the electron energy band gaps in materials such as anthracene and naphthalene. There is a short discussion of the relevant experimental results. D.J.Oliver

537.311.4 : 621.315.59

6985. TRANSIENT BEHAVIOR OF THE OHMIC CONTACT.

M.A.Lampert and A.Rose.

Phys. Rev., Vol. 113, No. 5, 1236-9 (March 1, 1959).

Under certain conditions the response time of a solid for current transients may be determined by the properties of the injecting contact rather than of the bulk. In this case, it is the time required for readjustment of the space-charge barrier at the contact for delivery of the new steady-state current. The critical parameter determining the response time of the contact is the total amount of excess charge within one Debye length of the potential minimum in the space-charge barrier. Trapped, as well as free, excess charge must be included in the calculation of the Debye length. The product of gain (G) and bandwidth ($1/\tau_0$) for a photoconductor whose response time is contact-controlled is derived and expressed in the "universal" form $G/\tau_0 = M/\tau_r$, where τ_r is the dielectric relaxation time under operating conditions.

537.311.62 : 537.312.62

6986. MAGNETIC FIELD DEPENDENCE OF THE SURFACE IMPEDANCE OF SUPERCONDUCTING TIN. M.Spiewak.

Phys. Rev., Vol. 113, No. 6, 1479-94 (March 15, 1959).

The surface impedance at 1 kMc/s of superconducting Sn has been investigated as a function of temperature, T, and of static magnetic field, H, both longitudinal and transverse to the r.f. current. The following unexpected phenomena have been observed. The r.f. resistance, R, and the reactance, X, may each decrease with increasing H. A decreasing X and an increasing R may coexist. A variation of either the crystalline or static field orientation with respect to the r.f. magnetic field can change the sign of $[R(H) - R(0)]$ and of $[X(H) - X(0)]$. For $T \leqslant 2.0$°K, both R and X are monotonically increasing functions of H. In this range of T, the approximation of a quadratic dependence for R on longitudinal and transverse H becomes increasingly unsatisfactory with decreasing T. The quadratic coefficient of the variation of X with longitudinal H also decreases with decreasing T, but the corresponding coefficient in transverse H increases, $1.2°\text{K} < T < 2.0°\text{K}$. The relation between these unexpected behaviours and previous experimental and theoretical studies is discussed.

537.312

6987. ON THE MECHANISM FOR CARRIER EXCITATION IN CdS.

D.D.Snyder and C.E.Bleil.

J. appl. Phys., Vol. 30, No. 5, 736-9 (May, 1959).

Induced conductivity in CdS crystals produced by electron bombardment (cathodoconductivity) and the associated X-ray production were studied employing electrons in the 30 to 60 keV range. The conductivity induced solely by these X-rays was studied. Using classical X-ray theory, the production and absorption of X-rays in the experimental crystals were calculated. Some confirmatory data are presented. From calculated excitation rates and observed conductivities the X-rays produced by impinging electrons are shown to be sufficient to explain the effects observed in cathodoconductivity, and may be significant in cathodoluminescence.

537.312.5

6988. QUANTUM EFFICIENCY OF THE PHOTO-ELECTRIC EFFECT IN GERMANIUM FOR X-RAYS.

J.Drahokoupil, M.Malkovská and J.Tauc.

Czech. J. Phys., Vol. 7, No. 1, 57-65 (1957).

By means of the photo-voltaic effect at a p—n junction the quantum efficiency of the internal photoelectric effect in germanium was measured for the X-ray wavelengths of 0.56, 0.71, 1.54, 1.93 A. It was found that, irrespective of the wavelength, an energy of 2.5 eV was needed in this region for the production of one electron—hole pair. This value corresponds well with measurements in the ultraviolet part of the spectrum.

537.312.5

6989. PHOTOPROPERTIES OF ZINC OXIDE WITH OHMIC AND BLOCKING CONTACTS. H.J.Gerritsen, W.Ruppel and A.Rose.

Helv. phys. Acta, Vol. 30, No. 6, 504-12 (1957).

Experiments on photo-effects in fine grained zinc oxide layers are described. Primary, as well as secondary, photo-currents were measured, respectively, with blocking and ohmic contacts. The primary photo-current shows saturation with voltage, and corresponds to a quantum yield close to unity. The rise time of the secondary photo-current is 10^4 times longer than that of the primary photo-current, under an illumination that produces in both cases an equal density of free carriers. The reduced lifetime of the primary photo-carriers in comparison with that for the secondary photo-carriers and the assumption of equal trap density in both cases are sufficient to account for this effect. A trap density of 10^{14} per cm^3 was obtained for the position of the Fermi level 0.8 eV below the conduction band and of 10^{17} per cm^3 for the position of the Fermi level 0.4 eV below the conduction band. Both values apply to the traps in an energy slice kT around the Fermi level.

537.312.5

6990. MEASUREMENTS OF THE DEMBER POTENTIAL IN BULK GERMANIUM. L.Stubbe and B.Gossick.

J. appl. Phys., Vol. 30, No. 4(1), 507-8 (April, 1959).

The potential difference across a semiconducting sample, which arises from a gradient of excess carrier density, and which depends on the mobilities of holes and electrons being unequal, has been observed. Measurements of this voltage and photoconductivity permit a determination of the ratio (mobility of electrons/mobility of holes) by a relation given by van Roosbroeck. The ratio 2.1 was obtained for germanium.

537.312.5 : 535.23.08

6991. INDIUM ANTIMONIDE PHOTOELECTROMAGNETIC INFRARED DETECTOR. P.W.Kruse.

J. appl. Phys., Vol. 30, No. 5, 770-8 (May, 1959).

The theory of operation, construction and performance data of an infrared detector based upon the PEM effect in InSb are presented. Theoretical derivations of the spectral noise equivalent input, noise equivalent power, and responsivity are made which show the dependence of these figures of merit upon the electrical properties of the semiconductor, sample thickness, surface area, front and back surface recombination velocities, and magnetic induction. Performance of the detector operating at room temperature shows a spectral response extending to 7.5 microns and a response time of less than 1 μsec. The noise equivalent input of a detector having a 0.71 mm^2 sensitive area has a minimum value at 6.6 microns of 6.7×10^{-10} W.

537.312.5

6992. PHOTOVOLTAIC EFFECT IN ORGANIC CRYSTALS.

H.Kallmann and M.Pope.
J. chem. Phys., Vol. 30, No. 2, 585-6 (Feb., 1959).

On irradiating one side of a thin single crystal of anthracene with 3650A, a photovoltage of max. 200 mV was obtained. Contact to two crystal faces was made with NaCl solutions as transparent electrodes. Positive charges diffuse through the crystal; this mechanism is discussed. J.Franks

537.312.5

6993. TRAPPING OF PHOTOELECTRONS AROUND DISLOCATION LINES IN ALKALI-HALIDES.

H.Kawamura and H.Okura.
J. Phys. Chem. Solids, Vol. 8, 161-3, 164-5 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The effect of plastic deformation on photoconductivity in coloured KCl and KBr is investigated. Care was taken to avoid formation of M or R centre complexes during irradiation by using purification by recrystallization. The carrier range is decreased by plastic deformation below −100° and −130°C for KCl and KBr respectively. Trapping by jogs is ruled out and is most likely to be on the dislocation lines. The activation energy for self-trapped electrons agrees with that found experimentally. G.F.J.Garlick

537.312.5

6994. CONCERNING THE PROBLEM OF EXCITON DIFFUSION IN PHOTOCONDUCTORS. I.Broser and R.Broser-Warminsky.

J. Phys. Chem. Solids, Vol. 8, 177-9, 193-5 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The photocurrent and the luminescence in optically shielded regions of an irradiated CdS crystal are quantitatively compared The results negate the validity of exciton diffusion theories for such crystals. G.F.J.Garlick

537.312.5

6995. CALCULATION OF THE PHOTOCONDUCTIVITY FROM A.C. IMPEDANCE CHANGES INDUCED IN ZnS AND ZnCdS PHOSPHORS. H.Kallmann, B.Kramer and P.Mark.

J. Phys. Chem. Solids, Vol. 10, No. 1, 59-63 (April, 1959).

To determine the true induced conductivity of ZnCdS-type phosphors, a.c. impedance measurements are required so that the barrier effects of the grains and electrodes can be eliminated. Five phosphors were investigated, and from the capacitance change and the dissipation factor determined at various frequencies and intensities the conductivity of the sample was obtained for homogeneous excitation. For non-homogeneous excitation the actual conductivity cannot be as easily determined, but the dependence of the conductivity on excitation can be determined. A comparison of theoretical and experimental results is given for the samples investigated.

537.312.5

6996. EFFECT OF THICKNESS OF THIN FILMS OF LEAD SULFIDE ON THE SPECTRAL RESPONSE OF PHOTOCONDUCTIVITY. H.E.Spencer.

Phys. Rev., Vol. 113, No. 6, 1417-20 (March 15, 1959).

The wavelength spectral responses of lead sulphide films of various thicknesses were measured between 1.6 and 3.1 μ. The effect of reflecting the transmitted radiation back on the cells was quantitatively studied. The fractions of light reflected and transmitted were also measured. It is concluded that the response per quantum absorbed is independent of wavelength. Simple absorption arguments are not valid for these films, probably because of the scattering of radiation due to the microcrystalline structure of the films.

537.312.5

6997. PHOTOELECTRIC EFFECTS IN CERTAIN OF THE ALKALI HALIDES IN THE VACUUM ULTRAVIOLET.

J.W.Taylor and P.L.Hartman.
Phys. Rev., Vol. 113, No. 6, 1421-35 (March 15, 1959).

An extensive search for internal photoconductivity in NaCl, KCL, KI and LiF resulting from stimulation by light of wavelength lying below the fundamental absorption edges of these crystals has yielded negative results. Photon energies employed ranged from about 6 eV to 21 eV. Calculations based on observed external photoelectric emission currents indicate that photoelectric quantum efficiencies as low as 10^{-8} electron per incident photon could have been detected if electrons travelled completely through the crystal. Measurements of the quantum efficiencies for external photoelectric emission by some of these crystals support the conclusion of Phillip and Taft that the valence bands of CsI and KI lie about 6.0 and 7.2 eV below the vacuum potential, respectively, and indicate that the valence bands of NaCl and KCl are 8.3 ± 0.1 eV below the vacuum. The valence band in LiF is tentatively placed at about 13 eV below the vacuum level. Energy distribution curves for the photoelectrons ejected from NaCl and KCl by photons of energies of from 10 to 21 eV show behaviour similar to that reported for Cs_3Sb, indicating that photoelectrons which have insufficient kinetic energy in the crystal to ionize another electron from the valence band will lose relatively little energy in escaping.

537.312.5

6998. GAIN–BANDWIDTH PRODUCT FOR PHOTOCONDUCTORS.

A.Rose and M.A.Lampert.
R.C.A. Rev., Vol. 20, No. 1, 57-68 (March, 1959).

The gain–bandwidth product for photoconductors is shown quite generally to have the form

$$G\frac{1}{\tau_0} = \frac{1}{\tau_{\mathrm{rel}}} M,$$

where G = photoconductive gain, τ_0 = response time, τ_{rel} = dielectric relaxation time, and M is a factor dependent on the trap distribution. For many materials the maximum value of M is shown to be unity. For these materials, the gain–bandwidth product approaches zero as the conductivity of the material approaches zero. The current performance of the Vidicon, Electrofax, xerography, and light amplifiers is quantitatively matched by M ≅ 1. So also, most of the data on the simple photocells using CdS and CdSe are consistent with M ≅ 1. Both analytical and experimental evidence indicates that M can be much greater than unity when the density of recombination states near the Fermi level exceeds the density of trapping states. Space-charge current flow in solids is important in the present analysis.

537.312.5

6999. PROPERTIES OF DEEP TRAPS DERIVED FROM SPACE-CHARGE-CURRENT FLOW AND PHOTOCONDUCTIVE DECAY. R.W.Smith.

R.C.A. Rev., Vol. 20, No. 1, 69-78 (March, 1959).

The states deep within the forbidden band of an insulator can be scanned either by moving the Fermi level by voltage injected carriers or by moving the Fermi level by optically excited carriers. The current–voltage characteristics of a single crystal of CdS were measured both in the dark and at different light levels over an extended range of voltages. From these data, along with photoconductive gain and decay time measurements, the performance (gain-bandwidth) of the photoconductor can be evaluated and some of the characteristics of the deep states determined. For the crystal measured, the dark current varied as V^2 in the low-voltage range and then increased steeply with V. This corresponds to the Fermi level starting in a trap-free region at ~0.9 eV below the conduction band and then sweeping through a single trapping level N_t of density $\sim 10^{14}$ per cm^3 at 0.8 eV. At low light levels the photoconductor M value attained a maximum value of 50 at the onset of space-charge current flow. As the Fermi level was raised by raising the light level the maximum M obtained decreased to approximately 5. M values greater than unity indicated that a predominant number of states at the 0.8 eV level were not functioning as traps but as recombination centres. The decay time, at a fixed light level, increased by as much as a factor of 100 as the voltage was increased to the onset of space-charge currents. This indicates that the photoconductive performance is determined by the states in the region of the contact rather than by the states in the body of the insulator.

537.312.5

7000. GAINS, RESPONSE TIMES, AND TRAP DISTRIBUTIONS IN POWDER PHOTOCONDUCTORS. H.B.DeVore.

R.C.A. Rev., Vol. 20, No. 1, 79-91 (March, 1959).

Gain and photocurrent decay measurements were made for CdS and CdSe powder photoconductors. These data are compared with the analytical expression derived by Rose and Lampert, relating gain–bandwidth product to dielectric relaxation time (see preceding abstracts). The gain–bandwidth product is, in the case of low illumination levels, considerably larger than the reciprocal relaxation time. This can formally be accounted for on the assumption of an admixture of recombination states and trapping states near the

Fermi level. Trap distributions were derived from photocurrent decay curves. These generally show a nearly exponential decrease of trap density with increasing trap depth below the conduction band.

537.312.5 : 539.2

PHOTOCONDUCTIVE RESPONSE OF CdS. EXCITON MIGRATION.

See Abstr. 6256

537.312.5 : 535.393

OPTICAL AND PHOTOELECTRIC PROPERTIES OF THIN METALLIC FILMS IN THE VACUUM ULTRAVIOLET.

See Abstr. 6777

537.312.6

7001. TEMPERATURE COEFFICIENTS OF RESISTANCE OF METALLIC FILMS IN THE TEMPERATURE RANGE 25° TO 600°C.

R.B.Belser and W.H.Hicklin.

J. appl. Phys., Vol. 30, No. 3, 313-22 (March, 1959).

The temperature coefficients of resistance (TCR) of films of sputtered Au, Ir, Mo, Ni, Pd, Pt, Rh, Ta, and W, of evaporated Al, Cr, Ti, and Zr, and of the alloy films Pt–Au, Pt–Ir and Pt–Ni were measured in vacuo over the temperature range 25° to 600°C; the film thickness range was 75 to 2000 A. The TCR values of films of the substantially pure metals were in the range $\frac{1}{3}$ to $\frac{2}{3}$ those of the respective bulk metals whether deposited on glass, Vycor, or Stupalith substrates. The departure of the conditions of growth of the film from those usual for the bulk metal, i.e., rapid cooling effects and impurities present, contributed imperfections which reduced the TCR of the film. The TCR values of alloy films were low, 0.0004 per °C for Au–Pt, and resistivities were 3 to 4 times that of either constituent. The TCR values of sputtered films of Mo, W, and Ta and of evaporated Cr, Zr, and Ti were generally less than 0.0001 per °C. Electron diffraction examination of films of these latter metals revealed oxide inclusions in the films. The presence of the oxide of the metal reduced the TCR and increased the R/sq of the film as compared to those of the pure metal. Only films of gold, platinum, and iridium were corrosion resistant in air near 600°C. Overcoats of evaporated SiO provided partial protection for the others. Powers up to 15 W were dissipated by refractory metal films only $\frac{1}{32}$ by $\frac{1}{2}$ in. and about 750 A thick. These high values contrasted with less than $\frac{1}{4}$ W for a gold film of similar dimensions.

537.312.62

7002. THE DESTRUCTION OF SUPERCONDUCTIVITY IN TANTALUM WIRES BY A CURRENT.

H.J.Fink.

Canad. J. Phys., Vol. 37, No. 4, 485-95 (April, 1959).

The transition from the superconducting to the normal state of various prestretched tantalum wires carrying current was investigated. When the resistance of the wire jumps discontinuously from the superconducting to the normal or intermediate state as a current is passed through it, then this current is defined as the critical current I_c. For temperatures $T < (T_c$-5 millidegrees K) the resistance of the wire jumps directly from zero resistance to its normal value at the critical current, such that the total cross-section of the wire goes effectively into the normal state. Between (T_c-5 millidegrees K) and T_c the resistance of the wire jumps at I_c to any fraction of the normal resistance between approximately zero and one. For constant temperatures the resistance–current plots show a large hysteresis effect. The transition temperature, T_c, of the various samples strongly dependent upon their resistivity at helium temperatures. If the wires with a small constant current (4.2 mA) flowing in them are cooled from above the transition temperature, the resistance decreases above T_c and approaches zero at approximately T_c, where T_c is defined by the extrapolation of the I_c-T curve to $I_c = 0$. If the wires are heated from below T_c the same resistance–temperature curves are reproduced.

537.312.62

7003. ON THE TRANSITION FROM SUPERCONDUCTING TO NORMAL PHASE, ACCOUNTING FOR LATENT HEAT AND EDDY CURRENTS.

A.J.W.Duijvestijn.

I.B.M. J. Res. Developm., Vol. 3, No. 2, 132-9 (April, 1959).

A rigorous solution is given for the superconducting transition of a semi-infinite slab held at a point below the critical temperature T_c when a constant magnetic field above the critical value H_{0c} is applied. The solution accounts for both the absorption of latent heat and the dissipation of eddy-current heat during the transition. A numerical example is calculated for the case of constants close to those of tantalum.

537.312.62

7004. GEOMETRIC EFFECTS IN THE SUPERCONDUCTING TRANSITION OF THIN FILMS.

M.D.Reeber.

I.B.M. J. Res. Developm., Vol. 3, No. 2, 140-6 (April, 1959).

A study is made of the effect of geometric factors and field orientation on the superconducting transition of bulk material whose dimensional ratios are comparable to those of thin evaporated films. An expression is derived for an effective demagnetizing coefficient in the direction of the applied field for an elliptic cylindrical superconductor, and it is shown that this deviates from 1 by quantities of the order of 10^{-2} or smaller for experimentally realizable conditions with typical films. These small coefficients give rise to surface fields sufficiently large for transition to the intermediate state. The shape of the transition for various field orientations has been obtained experimentally, and these curves are analysed qualitatively on the basis of Landau's and Andrew's theory of the intermediate state. For temperatures below the transition point, and in the absence of fields other than the earth's magnetic field, the possibility that these films are in the intermediate state is explored.

537.312.62

7005. "THIN-FILM" EXPERIMENT WITH BULK SUPERCONDUCTORS.

H.Meissner and R.Zdanis.

Phys. Rev., Vol. 113, No. 6, 1435-45 (March 15, 1959).

Hollow cylindrical samples of indium were prepared by an extrusion process and equipped with both a centre wire and a concentric tube. The critical current determined for the case in which the current passes through the sample and returns through the concentric tube. It was found that this critical current is identical with that of solid samples. The same determination was made for the case in which the current returns through the centre wire. In this case the critical current is about 80 to 90% of that for solid samples. A field was produced by the centre wire, the respective current returning through the concentric tube. The resistance of the sample was measured with a small measuring current, also returned through the concentric tube, as a function of the field produced by the centre wire. The critical field thus determined depends on the value of the measuring current. These findings can be interpreted in the following way: if the magnetic field of the current through the centre wire is dominating, the current in the sample will flow in a very thin layer at the outer surface of the sample. This constitutes a "thin film experiment" which does not require a thin metal film. The resistance measurements were supplemented by measurements of the circular flux on a sample of larger size.

537.312.62

7006. NUCLEAR SPIN RELAXATION IN NORMAL AND SUPERCONDUCTING ALUMINUM.

L.C.Hebel and C.P.Slichter.

Phys. Rev., Vol. 113, No. 6, 1504-19 (March 15, 1959).

Nuclear spin–lattice relaxation times have been measured in normal and superconducting Al from 0.94°K to 4.2°K, and as a function of static field in the normal state. In the normal state the relaxation rate is proportional to temperature as predicted by Redfield and others. The field dependence is somewhat greater than predicted. Relaxation in the superconductor was studied by a field cycling method which allowed the measurements to be made in the normal state but relaxation to occur in the superconductor. The results disagree with a simple two-fluid model, but are explained by the theory of Bardeen, Cooper and Schrieffer. The contrast between the temperature dependence of nuclear relaxation and ultrasonic absorption confirms the central feature of the Bardeen–Cooper–Schrieffer theory that electrons of opposite spin and momentum are correlated.

537.312.62

7007. SUPERCONDUCTIVITY OF In_2Bi.

R.E.Jones and W.B.Ittner.

Phys. Rev., Vol. 113, No. 6, 1520 (March 15, 1959).

In_2Bi is found to be superconducting at 5.6 ± 0.1°K. The compound InBi is not superconducting above 1.5°K.

537.312.8

7008. ON THE PHENOMENON OF DE-ELECTRIFICATION OF SMALL CONDUCTING BODIES IN AN EXTENDED ELECTROMAGNETIC HIGH-FREQUENCY FIELD.

H.Stolz.

Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 6-8, 334-43 (1958).
In German.

The expression for the de-electrification field is applied to a conductor whose dimensions and depth of skin-effect are small compared with the internal and external wavelengths of a high-frequency field. The dependence of the current density and internal field on the external field is calculated, and the results are applied to Ge for a temperature range of 0-200°C and a wavelength of 1.24 cm of the external field. W.A.Hepner

537.312.8

7009. THE THEORY OF ELECTRICAL AND PHOTOELECTRIC EFFECTS FOR THREE CARRIERS IN A MAGNETIC FIELD.

A.K.Walton and T.S.Moss.

Proc. Phys. Soc., Vol. 73, Pt 3, 399-412 (March, 1959).

Formulae for the Hall, magnetoresistance, photoelectromagnetic and Dember effects due to electrons and slow and fast holes are derived for the cases of energy independent relaxation time and lattice scattering. The expressions given are evaluated as far as the third order in magnetic fields for small magnetic fields and as far as the first order for large magnetic fields. They readily reduce to formulae which agree with those expressions which have so far been published. The results are discussed for the particular case of germanium.

537.312.8

7010. SOME ADIABATIC AND ISOTHERMAL EFFECTS IN BISMUTH TELLURIDE. W.Williams.

Proc. Phys. Soc., Vol. 73, Pt 5, 739-44 (May, 1959).

Isothermal and quasi-adiabatic Hall and Nernst coefficients were measured on n- and p-type Bi_2Te_3 over a temperature range 100°K to about 450°K. The current flow was parallel to the cleavage planes and measurements were made with the magnetic field either parallel or perpendicular to the cleavage planes. The difference between the two Hall coefficients follows the expected variation with temperature. However, the Nernst coefficients do not, and the reason is not known. Results obtained with the magnetic field perpendicular to the cleavage planes have been used to calculate the Ettingshausen coefficient.

537.32

7011. THERMOELECTRICITY AT VERY LOW TEMPERATURES.

D.K.C.MacDonald.

Science, Vol. 129, 943-9 (April 10, 1959).

Review article.

537.32

7012. ON THE THERMOJUNCTION FOR A.C. USE.

M.Nakamura.

Sci. of Light (Tokyo), Vol. 6, No. 1, 9-19 (March, 1957).

An experimental investigation of the characteristics of thermocouples used as radiation detectors with particular attention to sensitivity and time constant. M.R.Hopkins

537.322 : 536.8

THEORY OF THE PELTIER HEAT PUMP. See Abstr. 6863

537.323

7013. EFFECT OF OXIDE IMPURITIES ON THE THERMOELECTRIC POWERS AND ELECTRICAL RESISTIVITIES OF BISMUTH, ANTIMONY, TELLURIUM, AND BISMUTH–TELLURIUM ALLOYS. R.A Horne.

J. appl. Phys., Vol. 30, No. 3, 393-7 (March, 1959).

The thermoelectric powers of bismuth and antimony are only slightly altered by the presence of Bi_2O_3 and Sb_2O_3, respectively, and the electrical resistivities are increased. The thermoelectric power of tellurium, however, is extremely sensitive to TeO_2 impurities. Bismuth–tellurium alloys show greatest sensitivity to oxide impurities when their composition is in the range corresponding to Bi_2Te_3. The thermoelectric powers of these materials depend in detail on the manner in which the thermal gradient is applied during measurement.

537.323

7014. THE THERMOELECTRIC POWER OF A SEMICONDUCTING DIAMOND. H.J.Goldsmid, C.C.Jenns and D.A.Wright.

Proc. Phys. Soc., Vol. 73, Pt 3, 393-8 (March, 1959).

The thermoelectric power of a p-type semiconducting diamond has been measured in the temperature range 220°K to 700°K. After subtracting an electronic component, estimated from the previous Hall effect measurements on the sample, it has been possible to determine the phonon-drag component of the thermoelectric power. This component has been found to vary with temperature approximately as $T^{-3.6}$, with a value of about 2.5 mV deg^{-1} at room temperature. The magnitude of the effect is of the order to be expected from the known behaviour of germanium and silicon.

ELECTRIC DISCHARGES

537.521

7015. ELECTRONS AND HARD X-RADIATION EXCITED IN A HIGH POWER PULSED DISCHARGE.

I.M.Podgornyĭ, N.G.Koval'skiĭ and V.E.Pal'chikov.

Dokl. Akad. Nauk SSSR., Vol. 123, No. 5, 825-7 (1958). In Russian.

Demonstrates experimentally by means of a magnetic spectrometer the presence of 300 keV electrons moving along the axis of the discharge chamber. Similar energies are observed in the X-radiation. T.Mulvey

537.521 : 539.18

7016. ENERGETIC SPECIES TRAPPED AT 4.2°K FROM GASEOUS DISCHARGES

G.J.Minkoff, F.I.Scherber and J.S.Gallagher.

J. chem. Phys., Vol. 30, No. 3, 753-8 (March, 1959).

The calorimetric technique developed by Broida and Lutes (Abstr. 3758/1956) for estimating the abundance of trapped atoms was further investigated. A number of difficulties were recognized, and an apparatus was constructed which embodies a compromise of the various requirements. The calorimeter is now heated rapidly to 40-50°K by a small heating coil, less heat being required when atoms or radicals are present in the deposit. The concentration is then deduced from the reduction in electric energy needed to raise the calorimeter to some particular temperature. The results for nitrogen, oxygen, argon, and krypton indicate that up to a few per cent of the original gas are trapped in an unstable form. The factors affecting the stabilization of energetic species are considered in the light of the results presented.

537.523 : 544.62

7017. CHARACTERISTICS OF A COMBINATION DISCHARGE AND ITS APPLICABILITY IN SPECTROCHEMICAL ANALYSIS OF METALS. H.E.Biber and S.Levy.

J. Opt. Soc. Amer., Vol. 49, No. 4, 349-55 (April, 1959).

A combination discharge, obtained by superimposing a low-voltage a.c. arc with condensed high-voltage discharges, was investigated with respect to its applicability in spectrochemical analysis of metals. The stability of this combination discharge is comparable to that of a spark discharge and it is considerably more intense than the spark discharge alone. The vaporization of the electrode material can be controlled to some extend independently of excitation. There are indications that this may contribute to an understanding of the influence of extraneous elements.

537.523

7018. ANODE-FALL MEASUREMENTS IN LOW PRESSURE DISCHARGES. E.Nölle.

Tech. wiss. Abhandl. Osram-Gesell, Vol. 7, 65-72 (1958). In Germa

Measurements of the anode-fall have been made for discharges in Ne, A and Kr mixed with Hg and also in the pure gases, for pressures of a few atmospheres. Anodes of Ag, Cu, Mo, Ni, Pt, Ta and W were used; the currents were of the order of 300 mA, and the anode-falls of the order of 10 V. The anode-fall was calculated from the potential drop in the positive column, obtained by means of probe but in addition, a maximum, minimum and mean value were determined from measurements of the kilocycle oscillations of the anode potential. A short theory of this effect is given and discussed in relationship to anomalous results of other workers in which only a mean value for the anode fall had been determined. It is further shown that the maximum anode-fall (a) increases with increasing discharge current density; (b) is independent of the anode material, and (c) is independent of the thermal energy of the electrons in the positive column. P.A.Young

537.523 : 621.315.618.9

7019. ELECTRICAL BREAKDOWN OF GASES AND VAPORS OF CHLORO-FLUORO-HYDROCARBONS.

C.N.Works and E.W.Lindsay.

Trans Amer. Inst. Elect. Engrs III, Vol. 77, 1659-63 (1958) = Pwr Apparatus Syst., No. 40 (Feb., 1959).

The electrical breakdown of low- and high-molecular-weight hydrocarbon gases and vapours as a function of the number of H atoms replaced by Cl and F is discussed. The relationship betwee electrical breakdown and the number of Cl and F atoms attached to the ring of trifluoromethylbenzene is given. The electrical breakdowns of cyclohexyl and aromatic ring compounds are compared. The variation of electrical breakdown with the number of trifluoromethyl groups attached to cyclohexyl and aromatic rings, and also the effect of the molecular weight on the electrical breakdown of straight-chain and cyclic compounds are shown.

537.523.4

7020. EFFECT OF HUMIDITY ON THE BREAKDOWN OF A 1 cm HOMOGENEOUS FIELD SPARK GAP IN AIR.

K.Phillips, K.R.Allen and A.Refsum.
Nature (London), Vol. 183, 532-3 (Feb. 21, 1959).

The breakdown voltages for 1 cm homogeneous field spark gaps in air at 20°C and 760 mm Hg pressure, obtained by a number of workers, are summarized. It is shown that if the breakdown voltages are corrected to allow for the humidity of the gas, the spread in their values lies approximately within the experimental error; whereas without this correction the spread is considerably greater. For the variation of breakdown voltage with changing humidity see Abstr. 3528(1959). W.G.Townsend

537.523.74

7021. THE STATISTICAL DELAY IN THE INITIATION OF A MICROWAVE PULSE DISCHARGE.

P.S.Bulkin and M.Z.Khokhlov.
Radiotekhnika i Elektronika, Vol. 3, No. 6, 806-10 (1958). In Russian.

A formula is derived for the probability of statistical delay in the initiation of a pulse discharge, due to the statistical nature of the action of the ionizing particles and the completion of the arc. Experimental investigation of a microwave pulse discharge shows good agreement with the theoretical formula. R.C.Glass

537.523.74

7022. THE INFLUENCE OF HUMIDITY ON THE INITIATION OF MICROWAVE PULSE DISCHARGES.

G.S.Solntsev and G.N.Zastenker.
Radiotekhnika i Elektronika, Vol. 3, No. 6, 811-18 (1958). In Russian.

The results of an experimental study of the influence of water vapour on the initiation of a microwave discharge in air at 3.2 cm are given. The arc power and the statistical delay time were measured. The results are found to be in agreement with a formula derived theoretically and show that the addition of a small quantity of water vapour does not change the discharge parameters. At vapour pressures of the order of the partial pressure of atmospheric oxygen an increase in the statistical delay time occurs. R.C.Glass

537.525 : 621.387

7023. RADIO-FREQUENCY [0.1-30 Mc/s] NOISE IN HOT-CATHODE GAS DISCHARGE TUBES.

Y.Akao and S.Kobayashi.
Mem. Fac. Engng Nagoya Univ., Vol. 10, No. 1, 64-70 (May, 1958).

The results show that the gas, gas pressure and discharge current have some considerable influence on the noise. In the tubes containing argon gas and mercury vapour, two different types of noise appear, depending on the condition of discharge, while the tubes filled only with argon gas have one type only. The distribution of noise along the tube axis suggests a possible origin and mechanism of noise generation.

537.525.5 : 621.387 : 621.327.4

7024. THE EFFECT OF TRIGGER PULSE POLARITY ON THE ANODE BREAKDOWN TIME OF THE COLD CATHODE ARC CONDUCTION TETRODE.

R.Feinberg.
J. Electronics and Control, Vol. 6, No. 3, 246-57 (March, 1959).

The anode breakdown time of the cold cathode arc conduction tetrode is found to be dependent on the trigger pulse duration if the trigger pulse is positive, but independent of the pulse duration if the polarity is negative. Thus it was possible with a given valve to vary its anode breakdown time, for example, from about 10 μsec to about 400 μsec by using a positive trigger pulse and changing its duration. The effect of the trigger pulse polarity on the controllability of the anode breakdown time is explained in terms of the difference of the respective initiations of the anode breakdown.

537.525.5

7025. NATURE AND ROLE OF IONIZING POTENTIAL SPACE WAVES IN GLOW-TO-ARC TRANSITIONS.

R.G.Westberg.
Phys. Rev., Vol. 114, No. 1, 1-17 (April 1, 1959).

The transition from a glow discharge to a transient arc induced in Al cathode tubes 145 cm long by shorting of a series resistor was studied for a variety of gases by observing currents at the electrodes, the potentials at various points in the tube using probes, and the movement of luminous pulses using photomultiplier tubes and fast oscilloscopes. By applying a d.c. power supply with up to 2600 V and a large capacity parallel to the discharge tube, and with due regard to proper impedance matching, relatively pure gases N_2, A, H_2, O_2, and mixtures of N_2 and O_2, were studied from 50 μ Hg up to several hundred microns. In addition, shorter tubes with Cu, Ni, Pt, Hg, W cathodes and filled with He, or N_2 at intermediate pressures up to 7.2 mm Hg, were briefly studied. The decrease of the series resistance increased the very low current in the normal glow mode to higher values up to 50 mA usually in the abnormal mode. With slightly oxidized cathodes, there followed, after times varying from 10^{-3} sec to many seconds, catastrophic breakdowns to a transient power arc of the order 10-20 A or more. The transition was initiated by a burst of electrons from the cathode yielding a cathode current increase to several amperes in ~(2 to 10) × 10^{-8} sec. This burst sends a luminous pip or pulse to the anode at velocities varying from 5 × 10^{6} to 8 × 10^{9} cm/sec, depending on pressure, voltage, and gas. On arrival at the anode, a luminous return arc plasma front moves towards the cathode with speeds from 10^{8} to 10^{9} cm/sec or more. When it arrives at the cathode, the conductivity is sufficiently homogenized along the column so that the current and luminosity increase along the whole column until the drain on the capacity lowers the supply voltage. The luminous pip, and to a less clearly defined degree the return plasma front, are accompanied by potential space waves which can be established by cross-plots yielding luminosity and potential distributions across the tube at various times. The transition appears to be initiated by a sudden breakdown of the oxide layer on the cathode as it thins by ion bombardment, causing a small fraction of the oxide molecules to be ionized within millimicroseconds, thus yielding the initial current burst. These electrons, accelerated by nearly the full potential drop across the dark space, move as ionizing potential fronts, accompanied by luminosity, with velocities in most cases dictated by the cathode fall potential. In O_2, when pressures permit effective photoionization within the tube length, the velocities of the front are increased up to 8 × 10^{9} cm/sec.

537.525.5

7026. AN ARC MAINTAINED ON AN ISOLATED METAL PLATE EXPOSED TO A PLASMA.

A.E.Robson and P.C.Thonemann.
Proc. Phys. Soc., Vol. 73, Pt 3, 508-12 (March, 1959).

It is shown theoretically that a cathode spot may be maintained on an isolated metal surface immersed in the plasma of a gas discharge. Two experiments are described in which arcs of this kind were produced on a mercury surface.

537.525.72

7027. INFLUENCE OF GAS PRESSURE AND APPLIED POTENTIAL ON JOSHI EFFECT IN HYDROGEN USING AN ALL GLASS OZONIZER.

D.P.Jatar.
J. Univ. Saugar, Part II: Sect. A, Vol. 6, No. 6, 60-75 (1957).

Studies of the discharge current and the Joshi effect, %Δi, in hydrogen under low frequency silent electric discharge using an all glass ozonizer are reported over a wide pressure range from 3 to 725 mm Hg. For very low pressure ($<$ 10 mm Hg), the current potential characteristic is a straight line. For higher pressures, it exhibits three distinct regions corresponding to the initial fast rise, the intermediate sag and the final fast rise. These correspond closely in respect of potential with the initial maximum, the intermediate minimum and the second maximum in the %Δi–V characteristics. For pressures beyond 250 mm Hg, a small positive Joshi effect is observed for potentials near the threshold potential. The role of ageing is to increase numerically the negative effect and to suppress the positive Joshi effect. Regarding its variation with pressure, %Δi is absent for very low pressures, is maximum at an optimum pressure (~25 mm Hg), and then diminishes again as the pressure increases. These results could not be explained on Joshi's theory of negative ion formation and are discussed on the new hypothesis of photo-denudation of the cathode. It is suggested that the three regions correspond to the space charge free, the space charge limited, and the steady corona regimes.

537.525.72

7028. THE FALL IN POTENTIAL ON GLASS ELECTRODES FOR THE LOW FREQUENCY SILENT ELECTRIC DISCHARGE IN AIR.

D.P.Jatar and H.D.Sharma.
J. Univ. Saugar, Part II: Sect. A, Vol. 6, No. 6, 76-83 (1957).

Values are given of the threshold potential for the low frequency silent electric discharge in air using tubes excited by external sleeves, tubes using plane glass and metal electrodes, wire-in-glass cylinder type Maze counters, and all glass ozonizers. In all cases the threshold potential is seen to be higher with glass electrodes than that with metal electrodes. The difference is ascribed to a fall in potential on glass electrodes. The magnitude of this fall in potential is computed to be 25% from plane glass electrodes. Taking this value for the correction, the threshold potentials for the Maze counters and the ozonizers are corrected. A comparison of these corrected values with the data of Townsend using metal electrodes reveals very good agreement for Maze counters while the agreement in the case of all glass ozonizers is found to be satisfactory.

537.525.72

7029. THE ANALYSIS OF HIGH-FREQUENCY RESONANCE DISCHARGE.

A.A.Glazov and D.L.Novikov.

Zh. tekh. Fiz., Vol. 28, No. 10, 2295-301 (1958). In Russian.

A discharge is produced in a magnetic field using frequencies from 50 to 100 Mc/s. Theoretical and experimental analyses for breakdown conditions and characteristics are given. The properties of a gas discharge plasma are analysed. M.W.Makowski

537.525.8

7030. PRODUCTION OF ATOMS BY A GLOW DISCHARGE IN DRY HYDROGEN.

F.D.Coffin.

J. chem. Phys., Vol. 30, No. 2, 593-4 (Feb., 1959).

Production of atomic hydrogen in a glow discharge in absence of water vapour or oxygen was confirmed by observation of the Balmer line spectrum. A.E.D.Heylen

537.525.83

7031. NEW HOLLOW CATHODE GLOW DISCHARGE.

A.D.White.

J. appl. Phys., Vol. 30, No. 5, 711-19 (May, 1959).

An experimental study was made of the properties and characteristics of a glow discharge to a nearly spherical hollow cathode. Current densities in excess of 0.5 amp/cm^2 can be drawn from the cathode with negligible deterioration from sputtering. In neon, the discharge exhibits a stable and reproducible negative volt—ampere characteristic at currents of a few milliamperes. At these currents, probe measurements indicate the plasma in the hollow contains ~1 V electrons in concentrations greater than 10^{13}/cm^3.

537.527.2

7032. THE SPACE CHARGE FIELD EMISSION HYPOTHESIS APPLIED TO HAYASHI DATA ON DISCHARGES THROUGH GASES.

H.Ritow.

J. Electronics and Control, Vol. 6, No. 3, 236-45 (March, 1959).

Previous experiments and studies led to the conclusion that electric discharges in air and in hydrogen are initiated by a space charge field together with an externally applied field. The sum of the two fields equals the emission field of the cathode material or that of a negative ion space charge. The hypothesis is applied to Hayashi data on discharges in air, N_2, O_2, H_2, CO_2 and illuminating gas. The results corroborate the hypothesis. The data lead to an indication of the degree of influence of arc light irradiation of the discharge.

537.527.5

7033. T—F THEORY OF ELECTRON EMISSION IN HIGH-CURRENT ARCS.

T.H.Lee.

J. appl. Phys., Vol. 30, No. 2, 166-71 (Feb., 1959).

Electron emission as a function of electric field, temperature, and work function was calculated numerically on a digital computer over wide ranges of these variables. The results were then combined with the space-charge equation to show that electron emission from the cathode of a high-current arc on low boiling point materials like copper and silver can be explained by the T—F mechanism. It is also shown that the positive ion current density required by the electron emission condition is of the right magnitude to satisfy the energy balance condition at the cathode. ["T—F" signifies "temperature—field"; see Abstr. 9290 (1954)].

537.528 : 621.315.615

7034. THE ELECTRIC STRENGTH AND HIGH-FIELD CONDUCTIVITY OF DIELECTRIC LIQUIDS.

T.J.Lewis.

Progress in dielectrics, 97-140. See Abstr. 6868 (1959).

A detailed review of experimental and theoretical work since about 1940. Sections are devoted to experimental techniques, conduction in dielectric liquids, electric breakdown, breakdown time-lag and miscellaneous investigations. 99 references are included. J.B.Birks

537.528

7035. ELECTRON DRIFT MOBILITY IN LIQUID n-HEXANE.

O.H.LeBlanc, Jr.

J. chem. Phys., Vol. 30, No. 6, 1443-7 (June, 1959).

The drift mobility was measured at field strengths below 2 kV/cm and at several temperatures in the range +27° to −47°. The drift mobility was found to vary with temperature as $\mu = \mu_0 \exp(-\Delta\epsilon/kT)$, where $\mu_0 = 0.3 \pm 0.2$ cm^2/V sec and $\Delta\epsilon = 0.14 \pm 0.02$ eV. The results indicate that electrons injected into the liquid neither behave as free particles nor are they permanently attached to form negative ions. It is proposed that the injected electrons are alternatively trapped and thermally untrapped many times during their drift through the liquid. The experimental quantity $\Delta\epsilon$ is interpreted as the average energy with which an electron is trapped. The origin of the traps is not evident, but possible trapping mechanisms are discussed.

537.528 : 535.376 : 621.315.615.2

EFFECT OF ELECTROLUMINESCENT IMPURITIES ON THE BREAKDOWN STRENGTH OF INSULATING LIQUIDS.

See Abstr. 6770

537.529 : 621.315.61

7036. DIELECTRIC BREAKDOWN IN SOLID INSULATION.

J.H.Mason.

Progress in dielectrics, 1-58. See Abstr. 6868 (1959).

A comprehensive review, mainly devoted to work since 1950. Topics discussed include intrinsic strength investigations, breakdown in divergent fields, breakdown by internal discharges, breakdown by surface discharges, electrochemical deterioration, and electrical tests for insulation. 115 references are included. J.B.Birks

537.529 : 621.315.61

7037. DIRECTIONAL BREAKDOWN EFFECTS IN CRYSTALS.

J.W.Davisson.

Progress in dielectrics, 59-96. See Abstr. 6868 (1959).

The directional breakdown phenomena in crystals are classified and discussed under the following heads: experimental techniques, experimental and theoretical background, breakdown paths in the alkali halides, star patterns, mechanical properties, the magnitude effect, sulphur, surface breakdown paths, metallic dendrites, breakdown paths in non-centrosymmetrical crystals, rupture breakdown, pre-breakdown orientation effects, and theories of path formation. 65 references are given. J.B.Birks

537.529

7038. SURFACE CHARGES PRODUCED ON INSULATORS BY SHORT- AND LONG-TIME IONIZATION.

S.I.Reynolds.

Nature (London), Vol. 183, 671-2 (March 7, 1959).

A rotating-probe electrometer (Abstr. 3227/1957) was used to study the distribution of surface charge on polyethylene and polyester resin surfaces after various electrical discharge treatments. J.Dutton

X-RAYS

537.531 : 539.1.07

7039. X-RAY INTERFERENCE MEASUREMENTS WITH A PROPORTIONAL COUNTER AND A SINGLE-CHANNEL DISCRIMINATOR.

A.Trost.

Z. angew. Phys., Vol. 10, No. 9, 404-10 (Sept., 1958). In German.

The construction and the performance of the counter and the discriminator are described in some detail. For advantages of this arrangement see Abstr. 4413 (1952). A.R.Stokes

537.531 : 541.18

7040. SMALL-ANGLE X-RAY SCATTERING FUNCTIONS FOR ELLIPSOIDS OF REVOLUTION AND RIGHT CIRCULAR CYLINDERS.

A.G.Malmon.

Acta cryst., Vol. 10, Pt 10, 639-42 (Oct., 1957).

The angular intensity dependence of X-rays scattered at small angles from randomly oriented particles in the colloidal size range has been evaluated numerically for ellipsoids of revolution and right circular cylinders of a wide range of axial ratios. The usefulness of the result with respect to experimental determination of colloidal shapes is discussed. It is shown that, for all the elongated shapes studied, subsidiary maxima which appear in the low-intensity region of the scattering curve are a function of the equatorial radius of the particle. The results are compared with a limiting expression for the scattering from very elongated cylinders at very large angles, and it is shown that this limiting expression is a good approximation for all elongated cylinders over a wide angular range. The subsidiary maxima are demonstrated experimentally in the scattering from solutions of randomly oriented tobacco mosaic virus.

537.531 : 541.18

7041. THE SMALL ANGLE X-RAY SCATTERING FROM POLY-DISPERSE SOLUTIONS OF ELLIPSOIDAL PARTICLES.
P.W.Schmidt.
Acta cryst., Vol. 11, Pt 10, 674-6 (Oct., 1958).

Calculations are made of the predicted intensity of scattering. By the proper choice of a distribution function for the particle radius the intensity can be expressed in terms of simple functions. Estimates suggest that the scattering is relatively insensitive to the form of the distribution function. Some possible applications of the calculations to analysis of scattering data from systems containing flattened and elongated particles are discussed.

537.531

7042. SMALL ANGLE SCATTERING OF X-RAYS BY PLASTICALLY DEFORMED SINGLE CRYSTALS.
W.H.Robinson and R.Smoluchowski.
J. appl. Phys., Vol. 30, No. 5, 617-21 (May, 1959).

The small angle scattering of X-rays from single crystals of magnesium plastically deformed in simple shear was measured in the angular range of 4' to 5°. The crystals were subjected to both unidirectional and cyclic shear stresses applied along the $[11\bar{2}0]$ direction. Thin slices of the deformed single crystals were prepared using strain-free cutting and polishing techniques. The thin slices had orientations such that the slip direction was either parallel or perpendicular to the incident X-ray beam in order to observe any anisotropy in the scattering that might be due to dislocations. It was found that those samples which contained deformation twins within the irradiated volume produced rather large scattered intensity. This scattered intensity is interpreted as being due to double Bragg scattering. The scattered intensity from other specimens was attributed to surface scattering. No evidence for small angle scattering by dislocations was found.

537.531

7043. SMALL-ANGLE SCATTERING OF X-RAYS AND NEUTRONS FROM DEFORMED METALS. H.H.Atkinson.
J. appl. Phys., Vol. 30, No. 5, 637-45 (May, 1959).

X-rays or thermal neutrons may be scattered at small angles from deformed metals due both to "true" small-angle scattering and to double Bragg reflections. These two effects are discussed theoretically and compared to see how one may be distinguished from the other in the results of experimental observations. Experiments are described on the small-angle scattering of X-rays from polycrystalline copper and single grains of aluminium deformed by cold-work or fatigued in pulsating tension. The results show in a direct and conclusive way that almost all of the scattering is due to double Bragg reflections. No surface scattering has been observed. Double Bragg reflections were eliminated in experiments on the small-angle scattering of cold neutrons from cold-worked and fatigued copper and aluminium. The results, which indicate the magnitude of the "true" scattering, are consistent with scattering from dislocations. Hence there is no direct evidence of the existence of cavities in cold-worked or fatigued metals as the result of small-angle scattering experiments with either X-rays or neutrons.

537.531

7044. SMALL-ANGLE SCATTERING OF X-RAYS FROM NEUTRON IRRADIATED COPPER.
H.H.Atkinson, R.E.Smallman and K.H.Westmacott.
J. appl. Phys., Vol. 30, No. 5, 646-9 (May, 1959).

The scattering of X-rays at small angles from polycrystalline copper is found to increase when the recrystallized metal is bombarded with fast neutrons. The observed effects above 2° are due to double Bragg reflections; below about $1\frac{1}{2}$° they can be explained in terms both of double reflections and "true" small-angle scattering. The results indicate that either small coherent regions (of diameter about 100 A) or severe strains are present in the irradiated metal. The results are consistent with other measurements (particularly of mechanical properties) on irradiated metals.

537.531

7045. STUDY OF X-RAY SCATTERING FROM FATIGUED METALS. K.Thomas and A.Franks.
J. appl. Phys., Vol. 30, No. 5, 649-55 (May, 1959).

Various explanations have been put forward to account for the low angle X-ray scattering from cold worked metals. The experimental results obtained by an examination of individual grains of polycrystalline fatigue specimens indicate that double Bragg reflection plays an important role in this phenomenon. The fatigue process resulted in the formation of subgrains, the misorientations within a grain amounting to 15°.

537.531

7046. ON THE MECHANISM OF THE SMALL ANGLE X-RAY SCATTERING FROM COLD WORKED METALS.
R.H.Neynaber, W.G.Brammer and W.W.Beeman.
J. appl. Phys., Vol. 30, No. 5, 656-61 (May, 1959).

The characteristic small angle X-ray scattering from cold worked polycrystalline foils of Cu, Al, and Ni is found to appear immediately when the foil is stretched in the X-ray beam at liquid air temperature. The scattering at a fixed angle is a reversible function of foil temperature as long as recrystallization temperatures are not exceeded. The temperature dependence is about twice that expected from the Debye temperature factor of an average Bragg reflection. It is postulated that the small angle scattering is the result of two successive Bragg reflections from two slightly misoriented subgrains of the same grain. The small angle scattering is found to be polarized. This can be understood only on the double Bragg scattering model. The double Bragg model was suggested by observations of occasional isolated small angle peaks from annealed foils. These have unusual characteristics which quickly eliminate any possible single scattering source. They are double scattering from two large annealed grains which sometimes accidentally satisfy all the orientation requirements.

537.531

7047. EXPERIMENTS ON DOUBLE BRAGG REFLECTIONS IN DEFORMED AND UNDEFORMED METAL FOILS.
H.Fricke and V.Gerold.
J. appl. Phys., Vol. 30, No. 5, 661-7 (May, 1959).

Observations of X-ray scattering from deformed and undeformed metal foils using an evacuated film chamber give evidence of double Bragg reflections. Experiments were done on single crystals and polycrystalline foils of aluminium and copper and also on an annealed powder sample of copper. The scattering was measured in the angular range from 1° to 50° and agrees very well with theoretical considerations of expected double reflection effects in different states of deformation. Diffraction by lattice defects in the deformed state cannot be observed because its intensity is too small in comparison to that of double reflections.

537.531

7048. SMALL ANGLE X-RAY SCATTERING FROM COPPER AND ALUMINUM UNDER CYCLIC STRESS.
J.C.Grosskreutz and F.R.Rollins.
J. appl. Phys., Vol. 30, No. 5, 668-74 (May, 1959).

Copper and aluminium samples were subjected to cyclic stress and run to fatigue while being held in an X-ray beam. Small angle scattering intensities were recorded at various stages of the fatigue life. These intensities were found to increase with the number of elapsed stress cycles. The observed angular dependence and intensity of the scattered radiation agrees most nearly with a double Bragg scattering mechanism. The relation of the fatigue mechanism to the formation of small angle subgrain boundaries responsible for the double Bragg scattering is not clear-cut. However, the evidence favours the view that the formation of subgrains, while probably necessary to the propagation of the fatigue crack, is not sufficient either for its formation or propagation. Complete annealing of the scattering was not possible, indicating that recrystallization does not take place following cyclic stress of the order of one-fourth the yield stress. No evidence exists for a widespread formation of voids in the fatigued specimen.

537.531 : 539.2

SMALL ANGLE SCATTERING FROM DISLOCATIONS IN DEFORMED SINGLE CRYSTALS. See Abstr. 7510-11

537.531 : 535.341

7049. LOW-ENERGY X-RAY ATTENUATION MEASUREMENTS FOR ELEMENTS OF LOW ATOMIC NUMBER. J.I.Hopkins.
J. appl. Phys., Vol. 30, No. 2, 185-7 (Feb., 1959).

Mass attenuation coefficients were measured for aluminium and copper in the energy range of 6 to 40 keV and for chromium, cobalt, nickel, and zinc in the energy range of 6 to 14 keV. The average most probable error is less than 3%, and the agreement with theory is good.

537.531 : 537.533

EFFECT OF VACUUM ON ELECTRON FOCUS IN X-RAY TUBE. See Abstr. 5805

537.531.8

7050. CORRELATION OF SECONDARY X-RAY INTENSITIES.
B.R.Banerjee.
J. appl. Phys., Vol. 30, No. 2, 249-51 (Feb., 1959).

Intensities of primary characteristic X-rays generated by electron bombardment of a target are logarithmically related to the difference between the electron-accelerating voltage and the critical excitation potential for the observed radiation. An analogous relationship has now been developed for secondary X-rays, generated by X-ray bombardment of a secondary target. The correlation was further extended to elements having atomic numbers from 28 to 56, and including several that are industrially important. This unexpected extension of the correlation to many elements should be particularly useful in fluorescent X-ray analysis.

537.531.85 : 548.736.1

7051. INTERFERENCE PHENOMENA WITH COMPTON SCATTERING. N.Norman.

Acta cryst., Vol. 11, Pt 1, 1-4 (Jan., 1958).

For some years it has been known that some diamonds give excellent divergent-beam patterns even when the crystal is irradiated with a parallel beam of X-rays. By using a filter technique it is shown that the cause of the pattern is Compton radiation emitted from the atoms within the crystal. Only mosaic-type diamonds give such lines on the photographic film. It is suggested that the formation of the lines is mainly due to secondary extinction, the Compton radiation being weakened and reinforced through reflections from the lattice planes.

ELECTRON EMISSION . ELECTRON BEAMS

537.533

7052. WORK FUNCTION OF SODIUM CHLORIDE.

L.J.Vasek and J.M.Anderson.

Proc. Phys. Soc., Vol. 73, Pt 5, 733-8 (May, 1959).

The work function ϕ of evaporated films of sodium chloride and the energy gap δ from the filled levels to the Fermi level have been determined by photoelectric measurements using the complete electrode substitution method. The values found are $\phi = 5.12(3) \pm$ $\pm\ 0.018$ eV and $\delta = 1.55(0) \pm 0.034$ eV.

537.533

7053. THE EFFECT OF COPPER ON THE WORK FUNCTION OF LIQUID TIN. T.C.Toye.

Proc. Phys. Soc., Vol. 73, Pt 5, 807-10 (May, 1959).

The effect of small quantities of copper, up to 1%, covering the eutectic at 0.7% Cu, on the photoelectric work-function of liquid tin has been determined by measurement of stopping potential when the surface is irradiated with light from a tin spark. It is found that the apparent value of the work function obtained changes with composition, the change being greatest near the eutectic. The results are briefly discussed with reference to other published work on structure effects in liquids.

537.533

7054. AN INVESTIGATION OF THE TEMPERATURE DEPENDENCES OF THE WORK FUNCTIONS OF METALS.

A.Gel'berg, B.Iosifesku, G.Komsha and G.Mussa.

Radiotekhnika i Elektronika, Vol. 3, No. 8, 1000-4 (1958). In Russian.

The authors claim greater accuracy (around 10^{-3}V) than in the relatively few previous experimental works on the subject. The method of displacement of the characteristics is used; the contact p.d. is thus obtained, i.e. the relative values of the work function Ψ, which is sufficient for a knowledge of the temperature dependence. The experimental tube and circuit are illustrated and described in some detail. The temperature dependence of Ψ for molybdenum is reproduced as an example; the curve can be written $\Psi(t) - \Psi(860) =$ $(-6.1897 \times 10^{-2} + 1.11 \times 10^{-6}t + 8.1921 \times 10^{-8}t^2 \pm 9 \times 10^{-4})$ volts, where t = temperature in degrees C. D.E.Brown

537.533

7055. AN INVESTIGATION OF THE AUTO-ELECTRONIC EMISSION OF LANTHANUM HEXABORIDE.

M.I.Elinson and G.F.Vasil'ev.

Radiotekhnika i Elektronika, Vol. 3, No. 7, 945-53 (1958). In Russian.

An auto-electronic cathode of lanthanum hexaboride is shown to allow considerable stationary (approx. 10 mA) and pulse (approx. 1 A) auto-electronic currents to be drawn, corresponding to current densities of approx 10^7 A/cm^2. An emission picture of the boride is shown, obtained with an electronic projector. The adsorption properties of the boride surface are discussed, together with its stability against ionic bombardment, and the stability of the geometric form of the emitter during preparation and vacuum working. Characteristic smoothing of the surface due to migration is not observed with high temperature processing as in the case of metals. The volt—ampere characteristics are straight lines and correspond to the theory of auto-electronic emission of metals. The article contains lg i = f(1/u) characteristics (i in μA, u in kV) in a wide range of conditions. All in all, LaB_6 emitters have great advantages over metallic types. D.E.Brown

537.533

7056. FIELD EMISSION FROM METAL WHISKERS.

A.J.Melmed and R.Gomer.

J. chem. Phys., Vol. 30, No. 2, 586-7 (Feb., 1959).

It was found that single crystal whiskers strong enough to withstand the stresses of field and ion emission could be grown from: Al, Cu, Fe, Ni, Si, Mo and C. The technique is briefly described. A.H.W.Beck

537.533

7057. WAVE-MECHANICAL CORRECTION FOR THE RICHARDSON—DUSHMAN EMISSION FORMULA. F.Ollendorff.

Arch. Elektrotech. (Berlin), Vol. 44, No. 3, 177-88 (1959).

In German.

Gives a transmission probability calculation leading to a value of about 50%, instead of the values of 90-95% quoted by earlier authors. If correct, this value leads to A values of about 60, in agreement with measurements which have not been already corrected for temperature coefficient of work function. A.H.W.Beck

537.533 : 621.387.032.213.13

7058. THE FORMATION AND STABILIZATION OF THE "HOT-SPOT" IN LOW-PRESSURE DISCHARGES. B.Kühl.

Tech. wiss. Abhandl. Osram-Gesell., Vol. 7, 73-84 (1958).

In German.

The formation of hot-spots on oxide-coated cathodes is considered for the particular case of a barium oxide cathode in a low pressure discharge in mercury. Two relationships between the temperature and area of the hot-spot are obtained, one from the use of Richardson's equation and the other from a consideration of the energy balance at the cathode (Joule heating of oxide-film, external heating, ion-bombardment, electron loss and radiation loss), together with the measured temperature variation of the transverse resistance of the oxide-film. These two relationships are solved graphically to give a temperature in agreement with that determined pyrometrically. The various heating and cooling processes are further considered in relationship to the stability of the arc, with and without the formation of a hot-spot; it is shown that, in agreement with observation, two stable discharge conditions are possible. P.A.Young

537.533 : 621.385.032.213.13

7059. NEW MECHANISM FOR THE GENERATION OF FLICKER NOISE. F.Fisher and I.P.Valkó.

J. appl. Phys., Vol. 29, No. 12, 1772 (Dec., 1958).

Noise measurements have been made on a number of oxide-coated cathode electron tubes: variations in cathode porosity were obtained by breaking down the cathodes at different temperatures. A definite correlation is observed between low-frequency flicker noise and cathode porosity, while high-frequency shot noise is apparently independent of porosity. The results agree with the theory of Lindemann and van der Ziel (Abstr. 1563B/1957; J. appl. Phys., Vol. 27, No. 10, 1179-83, Oct., 1956) that flicker noise is mainly due to voltage fluctuations in the surface layer. C.H.B.Mee

537.533 : 621.385.032.213.13

7060. FEATURES OF THE SATURATION PROCESS IN SEMICONDUCTOR THERMO-CATHODES. K.B.Tolpygo.

Radiotekhnika i Elektronika, Vol. 3, No. 8, 980-9 (1958). In Russian.

A theory is developed for the change in thermal emission current of a semiconductor cathode on varying the anode voltage. The effect of the boundary field and of the current passed on the concentration of conductance electrons in the surface layer of the semiconductor is taken into account. The diffusion equation and Poisson's equation connecting the field and electron concentration are solved on the assumption of weakly ionized donor levels. The temperature dependence is found for the "saturation current" λ_0 (the current corresponding to zero field at the cathode surface). The relationship is established between the boundary field and electron concentration, then the volt—ampere cathode characteristics

e derived for a plane distribution of electrons (in the absence of
rface charges). The simple assumption is next made of two
stems of acceptor and donor surface levels occupying different
des of the Fermi level, such that the surface charge of the semi-
nductor is zero in the absence of current; the volt—ampere char-
teristics are plotted with λ_0 = 0.1 to 1.0. Theoretical justification
given of the familiar experimentally observed change in the form
the volt—ampere characteristics with temperature, and the effect
surface charge on the operation of a thermo-cathode in pulse
rvice is explained. D.E.Brown

537.533 : 621.385.032.213.13

61. THE EMISSION PROPERTIES OF RARE EARTH OXIDES.

S.Kul'varskaya, V.B.Marchenko,and G.V.Stepanov.
diotekhnika i Elektronika, Vol. 3, No. 8, 1005-9 (1958). In Russian.

The results are only given for measurements on spray layers
few thousand angstrom thick of most rare earth oxides. The
efficient σ of secondary electron emission was measured as a
nction of the speed U_p and angle of incidence ϕ of the primary
ectrons; typically, σ is shown plotted in the range U_p = 100-1000 V,
r holmium, samarium, gadolinium, and lutetium oxides, for ϕ
nstant; whilst $\sigma = f(U_p)$ is shown for Yb_2O_3 for $\phi = 10^0, 20^0, 30^0$.
table gives σ_{max} and the corresponding U_p for 13 oxides. The
chardson plot method was used for the thermal emission proper-
es. Plots are illustrated for 4 oxides. The work functions and
nission constants A were determined, as also the optimum states
activation. The general conclusion is that a whole series of
ides, notably those of yttrium and gadolinium, could be used for
bstitution of present-day thoriated cathodes. D.E.Brown

537.533 : 621.385.032.213.13

62. THE THERMO-ELECTRONIC PROPERTIES OF BARIUM UNGSTATE.

M.L.Kapitsa, A.I.Mel'nikov, A.V.Morozov,
N.Popov, R.B.Sobolevskaya, B.M.Tsarev and A.R.Shul'man.
diotekhnika i Elektronika, Vol. 3, No. 8, 1010-16 (1958).
Russian.

Directly heated cathodes were used for the measurements, with
ngsten or molybdenum bases, mainly in experimental diodes. The
thode coatings were Ba_3WO_6 or Ba_2CaWO_6 or mechanical mixtures
these. Temperature was measured by the change in resistance of
e base. Illustrations include: Richardson plots for one cathode
tivated at 6 different temperatures T, accompanied by a table of
rresponding current densities j and work functions ϕ; log j as a
nction of T for 3 cathodes activated above 1200° K; a table of 19
thodes with T_{active}, ϕ, j at 1100° K, and depth of coating (about
to 50μ); a table indicating that Schottky temperature differs from
easured temperature by a factor of 4-6; curves and a table indica-
g a ϕ of 1.3 eV below 900° K, ϕ = 0.6 - 0.7 from 900 to 1250° K,
ally a drop of current with increasing temperature. Though these
tter figures open the way to some argument as to the validity of
e results, the authors are inclined to think that the high emission
operties of barium oxide are shared by the tungstate and probably
her barium compounds. D.E.Brown

537.533 : 621.385.032.213.13

63. THE EFFECT OF CERTAIN GASES ON THE EMISSION OF N OXIDE CATHODE.

G.A.Zykov and N.G.Nakhodkin.
diotekhnika i Elektronika, Vol. 3, No. 8, 1031-9 (1958). In Russian.

The gases in question are oxygen, hydrogen, carbon monoxide
d chlorine; the cathode is that of the 6J2P production-type valve.
r O_2, curves show the ratio of emission current I to initial I_0
a function of poisoning and recovery time t for a cathode temp-
ature T = 1020° K, and pressure p = 7×10^{-7} mm Hg; curves tend
an equilibrium position with successive exposures of the cathode
the gas. Similar curves are drawn with the trap cooled by liquid
ygen. Curves for CO are I/I_0 as a function of t for different p
d different T. The ratio of equilibrium current I_∞ of poisoned
thode to I_0 is shown as a function of log p for O_2 and CO. Meas-
ements with hydrogen merely confirm Wagener's results. Curves
milar to the above are shown for chlorine. One of the main
sults is that a critical pressure exists for the poisoning gas, below
ich it has no action on the cathode during a matter of 10-50
nutes. D.E.Brown

537.533 : 621.385.032.213.13

64. THE EFFECT OF THE VAPORIZATION PRODUCTS OF IE THERMIONIC-CATHODE MATERIAL ON THE TRANSFORM- TIONS OCCURRING IN METALLIC OXIDES SUBJECTED TO ECTRON BOMBARDMENT.

G.S.Mikhailov.
diotekhnika i Elektronika, Vol. 3, No. 8, 1040-2 (1958). In Russian.

Successive bombardments were carried out on BaO, ZrO_2, ThO_2, CeO_2, CuO in the form of fine powder (about 10 μ) situated on the water-cooled copper anode of an experimental diode. Considerable heating of the latter was observed (up to 2000° C) on using an oxide, but not a purely metallic, cathode. Experimental conditions were U_a = 600 V, I_a = 100 mA, initial vacuum = 5×10^{-6} mm Hg, anode—cathode spacing = 5 mm. All cathodes were directly heated; the oxide cathodes had bases of tungsten, tantalum, molybdenum, tantalum with baked tungsten powder; the latter base served for the thoriated cathode. D.E.Brown

537.533

7065. A QUANTITATIVE ANALYSIS OF THE ALKALI METALS CONTAINED IN SOME PHOTO-CATHODES.

Yu.Nemilov and V.Privalova.
Zh. tekh. Fiz., Vol. 28, No. 8, 1717-18 (1958). In Russian.

A flame-photometer analysis of several photocathodes, nominally either Cs—Sb, KNa—Sb, or Li—Sb, showed gross contamination (several %) with unintended alkali metals. Results published on Li—Sb photocathodes (Nemilov and Privalova, Abstr. 8803/1956) are open to reinterpretation. K.F.Hulme

537.533 : 535.345.6

7066. OPTICAL FILTER FOR THE COMPENSATION OF THE SPECTRAL EFFICIENCY DISTRIBUTION OF PHOTOCATHODES.

K.Luchner.
Z. InstrumKde, Vol. 66, No. 12, 244-5 (Dec., 1958). In German.

Describes a composite filter, built up from circular sections of appropriate (coloured) glass, the angle of each section being chosen so as to give the correct weighting factor for the range of wavelengths transmitted. A.H.W.Beck

537.533

7067. ELECTRON EMISSION AT HIGH FIELDS DUE TO POSITIVE IONS.

P.Kisliuk.
J. appl. Phys., Vol. 30, No. 1, 51-5 (Jan., 1959).

Two mechanisms were proposed to account for the observed large yield of secondary electrons in gaseous breakdown at high electric fields. In one of these a single ion in approaching the cathode surface creates a "pass" by decreasing the width of the potential barrier. In the other the increased overall field due to a large number of ions in the gap is supposed to account for the increased emission. The first effect is re-examined and appears to be effective in the observed breakdowns of extremely small gaps in air. It may also be effective in breakdown at high pressure and in liquid and solid dielectrics.

537.533

7068. SECONDARY ELECTRON EMISSION FROM MgO THIN FILMS.

N.R.Whetten and A.B.Laponsky.
J. appl. Phys., Vol. 30, No. 3, 432-35 (March, 1959).

The secondary electron emission properties examined using both single pulse and d.c. measurement methods. High yields in the range of 15-20 are observed. The films are crystalline with an average crystal diameter of 100-500 A, comparable to the escape depth of the secondaries. The high yields are found to result primarily from the properties of bulk crystalline MgO rather than from thin film phenomena. Field enhanced emission is however observed and has been found to enhance the yield under some conditions by as much as 20%. The most probable energy of emission of the secondaries is about 1 eV. The yield of the films decreases upon exposure to water vapour and carbon dioxide. The films are found to be fairly stable under electron bombardment.

537.533

7069. SPACE-CHARGE SIMULATION IN AN ELECTROLYTIC TANK.

T.Van Duzer and G.R.Brewer.
J. appl. Phys., Vol. 30, No. 3, 291-301 (March, 1959).

Simulation is by the introduction of currents into the electrolyte by means of sources projecting through the tank floor. The theory and design criteria for this system are presented. This method of simulation is used as a means for introducing detailed space-charge effects into the determination of electron trajectories in axially symmetric, high-perveance electron guns. The trajectories determined by use of this system are compared with beam characteristics measured experimentally.

537.533 : 621.385.64 : 621.385.2

7070. KINETIC THEORY OF SPACE-CHARGE. II. ELECTRON COLLISIONAL DAMPING IN THE MAGNETRON (AND DIODE).

L.Gold.
J. Electronics and Control, Vol. 6, No. 3, 209-35 (March, 1959).

For Pt I, see Abstr. 5524B (1957); J. Electronics and Control, Vol. 3, No. 1, 97-102 (July, 1957). A detailed phenomenological treatment is given to the electron scattering contribution to magnetron and diode behaviour; the connection with the strong scattering limit presented earlier is provided, along with the reduction to the classical conservative motion theory. Generalized trajectory relations are derived for the non-conservative motion and the electric field and charge distribution characterized for diverse combinations of magnetic field, scattering frequency and transit time. The current—voltage relation is obtained in a parametric form from which numerical evaluation of the behaviour (for the same variable used in the electric field and charge distribution plots) clearly reveals the deterioration of the cut-off as the electron scattering mounts; this is particularly well demonstrated by plots of current versus magnetic field (actually cyclotron frequency) at constant voltage. The effect of electron initial velocities is suggested by cursory consideration of one set of values. The role of the Debye length in electron—electron scattering is pointed out in connection with work by Fulop, which provides some confirmation of the present theory. Calculation of the electron kinetic energy gain shows increasing thermal loss to the space charge as collisional damping grows.

537.533 : 621.385.2

7071. AZIMUTHAL ELECTRON FLOW IN A SPHERICAL DIODE. W.E.Waters.

J. appl. Phys., Vol. 30, No. 3, 368-73 (March, 1959).

Solutions of Poisson's equation for a space-charge-limited spherical diode, in which electron trajectories are great circles rather than radial lines, are developed. It is shown how Poisson's equation may be separated to yield ordinary differential equations. The radial equation is solved analytically, whereas accurate numerical solutions of the azimuthal equation are given. A method of truncating the flow so as to produce a "bowl-shaped" electron gun, leading eventually to an annular electron beam, is presented, along with power-series solutions of Laplace's equation both inside and outside the region of the flow. The latter series are useful for calculating the shapes of anodes and focusing electrodes.

537.533 : 621.385.2 : 621.362

7072. THERMIONIC DIODE AS A HEAT-TO-ELECTRICAL-POWER TRANSDUCER. W.B.Nottingham.

J. appl. Phys., Vol. 30, No. 3, 413-17 (March, 1959).

The high-vacuum thermionic diode is shown to be capable of converting heat to electric power. For this purpose, a low work-function collector, a small spacing, and sufficient temperature difference between the emitter and the collector are necessary. A detailed understanding of both thermionic emission and space-charge phenomena are needed for evaluating the effectiveness of this transducer. With V_R defined as the critical bias potential that gives zero potential gradient at the collector, the maximum available power is given by the relation $3.7 \times 10^{-6} V_T^{1/2}(V_R^2/w^2)$ watts/m^2. Here, V_T is the voltage equivalent of the temperature T/11 600. In the range of emitter temperature from 1200°K to 1700°K, the most optimistic conversion efficiency lies between 3 and 4% for a diode of 0.001 inch spacing. With a suitable choice of emitter inhomogeneity, the introduction of caesium vapour should improve the efficiency of this device.

537.533 : 621.385.2 : 621.362

7073. CONVERSION OF HEAT TO ELECTRICITY BY THERMIONIC EMISSION. V.C.Wilson.

J. appl. Phys., Vol. 30, No. 4(1), 475-81 (April, 1959).

A heat engine and electric generator is described which is a vacuum or gas filled device containing a hot cathode and a cold anode. Heat at the cathode lifts electrons out of the cathode and to a high (negative) potential in the system. By collecting the electrons on a low work function surface, part of the potential energy may be retained to use in an external circuit. Thus part of the heat that lifts the electrons out of the cathode may be converted into electrical energy. Cs vapour filled tubes have been built and tested as thermionic converters. A hot surface ionized part of the Cs vapour to neutralize space charge between the cathode and anode. The Cs vapour was also used to adjust the work functions of the two surfaces. A thermionic converter has been built which converts 9.2% of the input heat into electricity. The output was 3.1 watts per cm^2 of cathode surface — 0.78 V at 4.0 amp per cm^2 of cathode surface.

537.533 : 621.385.2 : 621.362

7074. THEORETICAL EFFICIENCY OF THE THERMIONIC ENERGY CONVERTER. J.M.Houston.

J. appl. Phys., Vol. 30, No. 4(1), 481-7 (April, 1959).

An analysis of the efficiency of the thermionic energy converter is given in terms of V_c and V_a, which represent the potential differences between the top of the potential barrier between the electrodes and the Fermi levels of cathode and anode, respectively. The analysis applies to all vacuum converters, and to gas-filled converters when the gas pressure is low enough so that the electron mean free path is greater than the cathode-anode spacing. In special cases, the analysis may also apply at higher gas pressures. It is shown (with certain assumptions) that optimum values of V_a and V_c exist. For V_a, the optimum is determined by the onset of thermionic emission from the anode to the cathode. For V_c, the optimum is determined principally by radiation losses. It is concluded that no fundamental reason exists why efficiencies of 30% or more cannot be realized in converting heat to electricity by this method.

537.533 : 621.385.2 : 621.362

7075. CALCULATION OF THE PERFORMANCE OF A HIGH-VACUUM THERMIONIC ENERGY CONVERTER. H.F.Webster.

J. appl. Phys., Vol. 30, No. 4(1), 488-92 (April, 1959).

The performance of a high-vacuum thermionic energy converter has been evaluated from Langmuir's 1923 paper on the thermionic diode. The results are presented in the form of a generalized set of curves which show output voltage as a function of current drawn from the device. These general curves have then been applied to a few specific cases to determine what cathode—anode spacings, and cathode and anode properties will be required to produce a practical energy converter.

537.533

7076. GRAPHICAL SOLUTION FOR HIGH-FREQUENCY ELECTROSTATIC DEFLECTION. M.H.Greenblatt.

Amer. J. Phys., Vol. 27, No. 5, 348-51 (May, 1959).

A graphical analogue, which obeys the same equations as an electron beam during deflection, is described. The transverse displacement and velocity of the beam can be calculated from this analogue, and certain details which are not obvious in the straightforward solution are apparent in the graphical-analogue solution. A proposal for a charged-particle beam-velocity measuring device is made. This proposal is based on behaviour revealed by the graphical-analogue solution.

537.533

7077. REPLY TO LETTER BY J.M.WINWOOD. B.Meltzer.

J. Electronics and Control, Vol. 5, No. 4, 348-9 (Oct., 1958).

Winwood's calculation (Abstr. 333/1959) of the ratio of magnetic to electric force exerted by one moving electron on another, is shown to contain three errors in the use of the Lorentz transformation of special relativity. It is also shown that the value obtained by Meltzer (Abstr. 7082/1958) is unaltered when relativistic corrections are taken into account. B.Meltzer

537.533 : 538.2

MAGNETIC ANALYSIS WITH ELECTRON BEAMS. See Abstr. 5882

537.533

7078. EPICYCLIC ORBITS OF CHARGED PARTICLES. E.R.Harrison.

Amer. J. Phys., Vol. 27, No. 5, 314-17 (May, 1959).

In a uniform magnetic field and a central force of the form $F = \xi r$, where ξ is a constant, charged particles describe epicyclic orbits in a plane perpendicular to the magnetic field for a limited range of ξ. These orbits are more varied than the simple trochoid which occurs when F is uniform. The orbits are of two kinds: the direct epicyclics and the retrograde epicyclics, corresponding, respectively, to motion occurring in central repulsion and central attraction force fields.

537.533

7079. ELECTRON OPTICAL PARAMETERS OF THE FIELD 1/r AND ITS APPLICATION IN NUCLEAR SPECTROSCOPY. I.Rezanka.

Czech. J. Phys., Vol. 8, No. 3, 355-65 (1958).

The parameters are calculated for an axially symmetric magnetic field, which in the central plane decreases inversely proportionally to the distance from the axis. The equipotential surfaces of this field are coaxial cones with a common vertex. The influence of the dispersion on the vertical focusing is estimated. The results obtained are used in proposing sector and prismatic beta spectrometers.

537.533

7080. THE SCALAR POTENTIAL FIELD OF TWO COAXIAL CYLINDRICAL ELECTRODES, OF THE SAME DIAMETER, WITH A CYLINDRICAL SCREEN. F.Böttcher.
Arch. Elektrotech. (Berlin), Vol. 44, No. 3, 189-202 (1959).
n German.

A solution of the Laplace equation, for the given boundary conditions, is obtained in the form of Legendre series. This is a purely mathematical study and no experimental results are given.

V.G.Welsby

537.533

7081. SPHERICAL ABERRATION OF WEAK MAGNETIC LENSES. P.Durandeau, B.Fagot and C.Fert.
C.R. Acad. Sci. (Paris), Vol. 248, No. 7, 946-9 (Feb. 16, 1959).
n French.

The focal properties of weak magnetic lenses are evaluated using the measured axial field distribution. The results are in greement with calculations by previous authors.

A.E.I. Research Laboratory

537.533 : 537.213

CYLINDRICAL ELECTRON LENS: POTENTIAL DISTRIBUTION AND ELECTRODE SHAPE FOR ARBITRARY SLIT WIDTH.
See Abstr. 6864

537.533 : 538.2

7082. POSSIBILITY OF POLARIZATION MICROSCOPY WITH ELECTRON BEAMS. S.Yamaguchi.
Naturwissenschaften, Vol. 44, No. 21, 555 (1957). In German.

Electron beams passing through a magnetic material, such as Fe_3O_4, are deflected or polarized on account of the spin interaction (Abstr. 1723/1958). When this occurs in a specimen in the electron microscope, the deflected electrons may be thrown out of the objective aperture, thus giving rise to extra contrast. The effect is illustrated by an electron micrograph of a film of Fe_3O_4 about 200 A thick.

V.E.Cosslett

537.533 : 621.385.032.213.13 : 621.385.833

7083. THE DEVELOPMENT OF ELECTRON MICROSCOPE METHODS FOR OBSERVING THE MICROGEOMETRY AND EMISSION CENTRES OF THERMO-CATHODES.
G.V.Spivak, E.M.Dubinina, I.S.Sbitnikova, I.A.Pryamkova and O.P.Vinogradov.
Radiotekhnika i Elektronika, Vol. 3, No. 8, 1077-83 (1958).
In Russian.

A detailed discussion of the factors determining the picture resolution (dimensions and contrast) is followed by a comparison of the secondary and thermal emission pictures of cathodes. A stroboscopic electronic emission microscope of large magnification is described and its immersion objective is illustrated by a sectional diagram. Useful magnifications of up to 4000 times were obtained with this latter from cathodes in pulse operation.

D.E.Brown

537.533 : 621.385.833

7084. A HIGH VACUUM EMISSION ELECTRON MICROSCOPE.
B.N.Popov and A.V.Druzhinin.
Radiotekhnika i Elektronika, Vol. 3, No. 8, 1084-91 (1958).
In Russian.

The construction is described and illustrated of an emission microscope with a residual gas pressure of 2 to 3×10^{-7} mm Hg, max. voltage 30 kV, magnification ×300 to ×5000. The device makes possible simultaneous observation of the emitting surface on a luminescent screen, external photography of the observed picture, and measurement of the current from a small part of the region under observation. The work function can be measured for different parts of the cathode. Provision is made for a special movable anode for activation of the cathode, designed to withstand large currents. The possibility is discussed of using the microscope for investigating porous metal and pressed cathodes.

D.E.Brown

537.533

7085. ON THE INFLUENCE OF ELASTICALLY SCATTERED ELECTRONS ON THE CONTRAST OF FLAT OBJECTS IN THE ELECTRON MICROSCOPE. W.Lippert.
Z. Naturforsch., Vol. 13a, No. 4, 274-8 (April, 1958). In German.

Inelastic scattering has a profound influence on contrast for light elements. Object thicknesses deduced from observed contrast by means of a theory restricting consideration to elastic scattering may consequently be in error by a factor of 2.

A.E.I. Research Laboratory

537.533 : 621.316.721 : 621.375.222

7086. USE OF OPERATIONAL AMPLIFIERS IN PRECISION CURRENT REGULATORS. K.Eklund.
Rev. sci. Instrum., Vol. 30, No. 5, 328-31 (May, 1959).

The design and construction of precision current regulators is simplified by the use of commercially available operational amplifiers. Their method of use is described and an example is given of a regulator used with an electron spectrometer, where the regulation obtained was 0.01%. It is felt that the use of operational amplifiers offers a great convenience to the physics laboratory. (See also Abstr. 7100.

537.533

7087. COULOMB SCATTERING IN A VERY STRONG MAGNETIC FIELD. L.M.Tannenwald.
Phys. Rev., Vol. 113, No. 6, 1396-405 (March 15, 1959).

The spiralling of charged particles in an intense magnetic field is taken into account in the description of their collisions involving small fractional momentum transfer. The transition probability to the continuum of possible states is given. In addition, the transition probability is given for a particle's orbit centre to be displaced from one magnetic line of force to another, with accompanying momentum change, as a result of scattering by a fixed charge. The equivalent results are derived for the scattering of two identical particles in their relative coordinate system. As the result of scattering, the momentum change along the magnetic field in a uniform, collimated beam of spiralling particles is found to be very much smaller than the sum of the magnitudes of the individual momentum changes in that direction. In contrast to ordinary Coulomb scattering, one finds that there is a lower limit to the momentum transfer to individual particles and that there is an adiabatic cutoff distance associated with the interaction which, in some plasma situations, can be shorter than the value of the Debye distance. The WKB approximation for generalized Laguerre polynomials is appended.

ION EMISSION . ION BEAMS

537.534

7088. A STUDY OF A HIGH-FREQUENCY ION SOURCE.
De Lacoste and J.Salmon.
Ann. Phys. (Paris), Ser. 13, Vol. 3, No. 5-6, 319-38 (May-June, 1958).
In French.

The advantages of r.f. ion sources, e.g. high proton yield, low energy spread, are briefly reviewed. The design and method of constructing such a source is given in detail. The energy of the beam was analyzed by a magnetic spectrometer. Methods of avoiding loss of output due to recombination in the canal are described.

A.E.I.Research Laboratory

537.534

7089. EXPERIMENTS ON A ION SOURCE FOR AN ELECTROMAGNETIC ISOTOPE SEPARATOR. F.Bisi and B.De Michelis.
Nuovo Cimento, Vol. 11, No. 6, 861-8 (March 16, 1959).

Describes a hot cathode, magnetic ion source for an electromagnetic isotope separator. The source, useful both for gaseous and solid charge materials, gives a total ion output of about 20 mA. Measurements on discharge characteristics, extracted currents and source efficiency are reported and the effects of introducing reflecting electrodes in the discharge chamber are discussed.

537.534

7090. A NEGATIVE HYDROGEN ION INJECTOR FOR A TANDEM ELECTROSTATIC ACCELERATOR. L.E.Collins and A.C.Riviere.
Nuclear Instrum., Vol. 4, No. 3, 121-8 (April, 1959).

A brief description is given of the ion source (r.f. type) and accelerating system. The source yields a current of 10 μA of negative hydrogen ions. The remainder of the system accelerates the ions under constant focusing conditions. The ion optical requirements for focusing of the first stage of the main accelerator are also discussed and compared with the performance of the injection system.

537.534

7091. HIGH-CURRENT ION SOURCE.
R.G.Meyerand, Jr and S.C.Brown.
Rev. sci. Instrum., Vol. 30, No. 2, 110-11 (Feb., 1959).

The source is of simple design and construction. It is capable of producing an ion beam of ½ A. The energy spread of the ions is large.

537.534

7092. STRONG FOCUSING ION SOURCE FOR MASS SPECTROMETERS. C.F.Giese.
Rev. sci. Instrum., Vol. 30, No. 4, 260-1 (April, 1959).

The source was developed with a view toward obtaining high transmission through sector-shaped magnetic fields. The lens described, starting with an ion beam 0.375 in. square, produces a line focus 0.60 in. long and 0.025 in. wide, with a half-angle of divergence beyond the crossover of 0.034 rad.

537.534

7093. ENERGY DISTRIBUTION OF HYDROGEN IONS FROM A HIGH FREQUENCY ION SOURCE. G.Forst.
Z. angew. Phys., Vol. 10, No. 12, 546-51 (Dec., 1958). In German.

The energy distribution of hydrogen ions was measured using a magnetic spectrometer and a retarding field method of detection. The main step in the distribution occurred at 70 eV but steps of 1000 eV also occurred. The parameters affecting energy distribution were also examined. A.E.I. Research Laboratory

537.534

7094. STABLE ORBITS OF CHARGED PARTICLES IN AN OSCILLATING ELECTROMAGNETIC FIELD. E.S.Weibel.
Phys. Rev., Vol. 114, No. 1, 18-21 (April 1, 1959).

Orbits in a field of the cylindrical waveguide driven in the TE_{01}-mode were studied. The radial components of the Lorentz force acting on the particle is never positive regardless of its charge; thus, it is attracted toward the axis of the waveguide around which it moves in a complicated path. Sufficient conditions are given under which the orbits are stable, that is, remain bounded for all times.

537.534 : 537.291

7095. ELECTRODYNAMIC CONTAINMENT OF CHARGED PARTICLES. R.F.Wuerker, H.Shelton and R.V.Langmuir.
J. appl. Phys., Vol. 30, No. 3, 342-9 (March, 1959).

Electrically charged iron and aluminum particles having diameters of a few microns were contained in a confined region of space by means of alternating and static electric fields. The theory is essentially that of alternating gradient focusing; here the motion is governed by Mathieu's equation. Under certain circumstances, when many particles are confined, the three-dimensional focusing force and the Coulomb repulsion results in a "crystalline" array which can be "melted" and reformed.

537.534

7096. CALCULATION OF THE ION OPTICAL PROPERTIES OF INHOMOGENEOUS MAGNETIC SECTOR FIELDS, INCLUDING THE SECOND ORDER ABERRATIONS IN THE MEDIAN PLANE. H.A.Tasman and A.J.H.Boerboom.
Z. Naturforsch., Vol. 14a, No. 2, 121-9 (Feb., 1959).

In first-order approximation the field is assumed to vary as r^{-n} ($0 \leq n < 1$); the term in the magnetic field expansion which determines the second-order aberrations is chosen independent of n, which makes the elimination possible of, for example, the second-order angular aberration. From the Euler—Lagrange equations the second-order approximation of the ion trajectories in the median plane and the first order approximation outside the median plane are derived for the case of normal incidence and exit of the central path in the sector field. An equation is presented giving the shape of the pole faces required to produce the desired field. The influence of stray fields is neglected. The object and image distances are derived, as well as the mass dispersion, the angular, lateral and axial magnification, the resolving power, and the inclination of the plane of focus of the mass spectrum. The maximum transmitted angle in the z-direction is calculated. The resolving power proves to be proportional to $(1-n)^{-1}$, whereas the length of the central path is proportional to $(1-n)^{-\frac{1}{2}}$. An actual example is given of a 180° sector field with $n = 0.91$, where the mass resolving power is increased by a factor 11 as compared with a homogeneous sector field of the same radius and slit widths.

537.534

7097. ION FOCUSING PROPERTIES OF A QUADRUPOLE LENS PAIR. H.A.Enge.
Rev. sci. Instrum., Vol. 30, No. 4, 248-51 (April, 1959).

A quadrupole lens pair was studied, and the results of thick-lens calculations are presented in the form of graphs showing the field strength parameters and magnifications as functions of object and image distances.

537.534

7098. A 180° MASS SPECTROMETER FOR ANALYSIS OF ORGANIC COMPOUNDS OF HIGH MOLECULAR WEIGHT. R.Ryhage.
Ark. Kemi., Vol. 13, Paper 47 475-84 (1959).

A spectrometer with heated inlet system, and intended for organic analysis, is briefly described. A complete spectrum can be obtained using about 0.5 μmole of the compound to be analysed, and unit resolution extends up to m/e 500. The mass range 12-300 is scanned in 4 min.

PARTICLE ACCELERATORS

537.54 : 533.5

VACUUM SYSTEM FOR 30 BeV ACCELERATOR. See Abstr. 6607

537.54

7099. LONGITUDINAL SPACE CHARGE EFFECTS IN PARTICLE ACCELERATORS. C.E.Nielsen and A.M.Sessler.
Rev. sci. Instrum., Vol. 30, No. 2, 80-9 (Feb., 1959).

The modification of the single particle theory of particles subject to radio-frequency acceleration caused by electrostatic repulsion between particles is calculated. With the aid of an appropriate Hamiltonian the Boltzmann equation is reduced to a one-dimensional integral equation for the case of a uniform particle density in a limited region of phase space. For a range of parameters that includes most accelerators, this equation is approximated by an algebraic equation, and an analytic solution valid below the transition energy is obtained. Computations are given of the "longitudinal space charge limit", as well as the effect of space charge on the azimuthal bunching of a beam by an accelerating cavity. Numerical examples of these two effects are given.

537.54 : 621.316.721 : 621.375.222

7100. USE OF OPERATIONAL AMPLIFIERS IN ACCELERATOR BEAM CONTROL SYSTEMS. K.Eklund.
Rev. sci. Instrum., Vol. 30, No. 5, 331-2 (May, 1959).

A basic preamplifier is used with various output stages to contr beam energy and position by magnetic and electrostatic means. The use of commercially available operational amplifiers provides great advantages in simplifying design, construction, and maintenance. (See also Abstr. 7086.

537.54

7101. SMALL-APERTURE DIAPHRAGMS IN ION-ACCELERATO TUBES. L.Cranberg and J.B.Henshall.
J. appl. Phys., Vol. 30, No. 5, 708-10 (May, 1959).

An investigation was made to determine the conditions under which the voltage sustained by a 2 ft length of ion-accelerator tube may be made proportional to the length of the tube. It was found that such linearity may be obtained if the tube is segmented at 4½ in. intervals by diaphragms which are so arranged that no straight path is possible from one end of the tube to the other. No significant deterioration in performance of the tube was observed when axial holes were made in each diaphragm up to ¾ in. in diameter. The voltage gradient realized on these tests was 60 kV/cm.

537.54 : 621.384.62

7102. ANOMALOUS ATTENUATION IN LINEAR ELECTRON ACCELERATORS. V.J.Vanhuyse.
Nature (London), Vol. 182, 1081-2 (Oct. 18, 1958).

An approximate theory is developed of the effect of stable multipactoring on the anomalous attenuation in linear electron accelerators at intermediate power levels. The phenomenon is explained and good agreement with experiment is obtained.

T.O.Jeffrie

537.54

7103. THE ANHARMONIC MOTION OF IONS IN A CYCLOTRON AND THE PHASE DIAGRAM. R.Keller.
Nuclear Instrum., Vol. 4, No. 3, 181-8 (April, 1959).

It is shown that the equation of the orbits in a cyclotron and a synchro-cyclotron is identical with that of a pendulum. The equations of motion are then derived for the radius of the orbits and for the phase, for an adiabatic variation, such as occurs in practice. A numerical example is given of the calculation of the maximum ener and of phase bunching for a given cyclotron. Stochastic acceleratio is illustrated by means of a phase diagram.

537.54

7104. IMPROVED CYCLOTRON PERFORMANCE FROM CONTROL OF INITIAL ION MOTION. A.H.Morton and W.I.B.Smith.
Nuclear Instrum., Vol. 4, No. 1, 36-43 (Jan., 1959).

Techniques have been developed to improve cyclotron beam characteristics by the use of slits near the ion source to obtain defined internal beams concentric with the cyclotron centre resulting in high extraction efficiencies, and monoenergetic external beams of small angular spread. The optics of the ion source and the use of focusing grids on early revolutions of the ions are discussed.

IONIZATION . PLASMA

537.56

7105. THE EFFECT OF THE SELF MAGNETIC FIELD ON THE TRANSPORT PHENOMENA IN A PLASMA. H.Schirmer.
Tech. wiss. Abhandl. Osram—Gesell., Vol. 7, 1-7 (1958).
In German.

A brief theoretical paper, referring to the earlier relevant work by Gans, in which the Boltzmann transport equation is used. Data are given for a xenon high pressure lamp. J.D.Craggs

537.56 : 536.23

7106. THE ELECTRICAL AND THERMAL CONDUCTIVITIES OF XENON HIGH PRESSURE PLASMAS. H.Schirmer.
Tech. wiss. Abhandl. Osram—Gesell., Vol. 7, 8-10 (1958). In German.

Data are presented for a pressure of 25 atm. The electrical conductivity, and the components of the "total thermal conductivity" and their sum, are given for temperatures ranging up to 9000°K.
J.D.Craggs

537.56

7107. PLASMA DYNAMICAL DETERMINATION OF SHOCK THICKNESS IN AN IONIZED GAS (A CORRECTION). E.N.Parker.
Astrophys. J., Vol. 129, No. 3, 860-1 (May, 1959).

See Abstr. 4743 (1959).

537.56

7108. SELF-CONFINING MOTION OF A CONDUCTING GAS IN A MAGNETIC FIELD. V.P.Korobeĭnikov.
Dokl. Akad. Nauk SSSR, Vol. 121, No. 4, 613-15 (1958). In Russian.

Equations for the gas plasma are established in a form which clearly demonstrates the coupling between internal and external magnetic fields via the charge and particle densities and their space and time derivatives. Stability criteria are defined and a "locus of critical coupling" is derived to satisfy these criteria.
J.W.Gardner

537.56

7109. LANGEVIN EQUATION AND THE A.C. CONDUCTIVITY OF NON-MAXWELLIAN PLASMAS. P.Molmud.
Phys. Rev., Vol. 114, No. 1, 29-32 (April 1, 1959).

The use of the Langevin equation

$$\{dv/dt + gv = (q/m)[E_0 e^{i\omega t} + (v/c) \times H]\}$$

to describe the electrical conductivity of a non-Maxwellian plasma (a weakly ionized gas in which the average electron collision frequency is temperature dependent) may be in error unless it is understood that the dissipative term, g, is complex. In the limiting cases of either high or low pressures the imaginary part of g is negligible. The real and imaginary parts of g are evaluated for these limiting cases, for four different gases: air, helium, Maxwellian gas, and water. The real part of g is shown to be the average collision frequency multiplied by a numerical factor, the size of which depends on the nature of the gas and the pressure limit.

537.56

7110. NEW EXPERIMENTAL RESULTS FOR PLASMA ELECTRON OSCILLATIONS. D.W.Mahaffey.
J. Electronics and Control, Vol. 6, No. 3, 193-203 (March, 1959).

An account of some experimental investigations of plasma electron oscillations in low-pressure mercury vapour discharges with plane oxide coated cathodes. The appearances of some of the discharges are described. The primary electrons were deviated laterally in or near the meniscus-shaped region of ionized gas brighter than the surrounding plasma, which appeared a few millimetres from the cathode. Variation of anode-cathode separation was found to have a marked effect on both the appearance of the deflected beams and the meniscus, and on the high-frequency oscillatory properties of the discharges. Measurements of plasma electron concentration and temperature were made simultaneously with measurements of oscillation intensity and frequency. A strong tendency was found for the oscillations to grow in amplitude when the beam of primary electrons moved down a concentration gradient and to die out when the beam moved up a gradient. The frequency of the oscillation was found to agree closely with that calculated from the Langmuir formula, using the plasma electron concentration at the position of appearance of the oscillation. Several checks were applied to the measurements of concentration, including measurements of the positive ion current flowing to a probe and measurements with double probes.

537.56

7111. GROWTH OF ELECTRIC SPACE-CHARGE AND RADIO WAVES IN MOVING ION STREAMS. J.H.Piddington.
Phil. Mag. (Eighth Ser.), Vol. 3, 1241-55 (Nov., 1958).

The following conclusions are reached: (i) In a medium comprising two identical interpenetrating ion streams, four electric space-charge phenomena may occur. The "fast" and "slow" travelling waves are not dealt with; the two effects of interest are non-travelling in a system in which the medium as a whole is at rest. (ii) The first is most probably a set of evanescent waves. These have erroneously been interpreted as spatially growing waves and as the basis of the electron-wave and similar amplifiers. (iii) The second effect is not an oscillation at all but an instability in the medium. A single space-charge cloud, however low its density, will, if its linear dimension is large enough, continously increase in density with time. The mechanism disclosed is quite simple and does not require, as previously suggested, a series of ion clouds (that is, a spatial wave). (iv) The effect may occur widely in nature, for example in the solar atmosphere (leading to patchiness and increased radio emission) in interstellar space and in the ionosphere (sporadic E). It also provides a physical picture of the action of the electron-wave tube. (v) An earlier criticism of Bailey's theory of radio waves growing in a medium which drifts along a magnetic field is consistent with special relativity theory. The consistency depends on a suitable definition of "growth", being an increase in amplitude away from the source of the wave. The original definition — increase in amplitude in the direction of travel — indicates growth of virtually all waves to suitably moving observers. (vi) The earlier criticism is also confirmed in discussing a previous Laplace transform analysis of the same situation plus a reflecting boundary. A new type of wave (the "transverse space-charge wave") described in this analysis is shown to be spurious and a corresponding theory of solar radio noise untenable.

537.56

7112. SPONTANEOUSLY GROWING TRANSVERSE WAVES IN A PLASMA DUE TO AN ANISOTROPIC VELOCITY DISTRIBUTION. E.S.Weibel.
Phys. Rev. Letters, Vol. 2, No. 3, 83-4 (Feb. 1, 1959).

The existence and rate of growth of transverse electromagnetic waves, involving only electrons in a plasma is derived from the Boltzmann transport equation. C.G.Morgan

537.56

7113. THE GYRO-RELAXATION EFFECT. A.Schlüter.
Z. Naturforsch., Vol. 12a, No. 10, 822-5 (1957). In German.

It is shown that, if the magnetic field changes with time or along the trajectories, a relaxation of the degrees of freedom of the motion along the lines of force occurs relative to those of gyration around these lines. The resulting increase in the temperature of a plasma may be used to attain very high temperatures. W.A.Hepner

537.56

7114. CERTAIN SOLUTIONS OF THE EQUATIONS OF PLASMA HYDRODYNAMICS. A.A.Vedenov.
Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1509-11 (1957). In Russian.
English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1165-7 (June, 1958).

Solutions are obtained describing the motion of a frictionless cold plasma in the following situations: (1) only H_z, E_x, v_x, v_y differ from zero, H_z is constant, and the other variables depend on x and t only; (2) only H_z, E_r, v_r, v_ϕ differ from zero, H_z is constant, and the other variables depend on r and ϕ only. The dependent variables have the form e^{-t/t_0} times a function of $[t/t_0 + \ln(x/x_0)]$ or $[t/t_0 + \ln(r/r_0)]$. The solutions appear to describe travelling plasma oscillations of finite amplitude. O.Penrose

537.56 : 537.224 : 621.319.4

HYDROMAGNETIC CAPACITOR. See Abstr. 6867

537.56

7115. NEGATIVE IONS OF OXYGEN. G.S.Hurst and T.E.Bortner.
Radiation Research, Suppl. No. 1, 547-57 (1959). See Abstr. 5164 (1959).

Reviews methods of elucidating the mechanism of electron capture by oxygen and describes experiments using electrons of mean energy of about 1 V. The results are interpreted in terms of the formation of 2 unstable O_2^-, followed by a stabilizing process.

A.E.I. Research Laboratory

537.56 : 539.1.07

7116. PRESSURE DEPENDENCE OF THE SATURATION CHARGE OF POLONIUM ALPHA-PARTICLES IN CO_2, AND IN A–CO_2 AND A–CH_4 MIXTURES. F.Widder and P.Huber.
Helv. phys. Acta, Vol. 31, No. 6, 601-24 (1958). In German.

The anomalous dependence of the saturation charge of Po-α-particles on pressure in ionization chambers filled with CO_2 is examined. New measurements were made with carefully purified CO_2. By means of the theory of Jaffé (1913), a graphic representation of saturation curves could be found, which gives a saturation charge independent of pressure. There the dependence of the mobility of electrons on field strength must be taken into account. Mixtures of 95% A + 5% CO_2, 70% A + 30% CH_4, and 80% A + 20% CH_4 were investigated also. These gas mixtures also show a dependence of the saturation charge of Po-α-particles on pressure when the dependence of the mobility of electrons on field strength is neglected. By taking into account the varying mobility of electrons, this dependence on pressure vanishes in the case of A–CO_2 mixture and is strongly reduced in the case of A–CH_4 mixtures. For the average energy loss per ion-pair of Po-α-particles, the following values were found: CO_2 34.0 ± 0.3 eV; 95% A + 5% CO_2 25.22 ± 0.11 eV; 70% A + 30% CH_4 27.43 ± 0.10 eV; 80% A + 20% CH_4 27.17 ± 0.12 eV.

537.561

7117. IONIZATION POTENTIALS OF SOME OLEFINS, DIOLEFINS AND BRANCHED PARAFFINS. J.Collin and F.P.Lossing.
J. Amer. Chem. Soc., Vol. 81, No. 9, 2064-6 (May 5, 1959).

The potentials were measured by electron impact. The results obtained were compared, where possible, with ionization potentials obtained by photo-ionization and by ultraviolet spectroscopy, as well as with earlier electron impact data. Values presented for a number of compounds which had not been investigated previously are consistent with structural considerations. Some inconsistencies in the earlier electron impact data are discussed.

537.561 : 535.343

7118. IONIZATION POTENTIAL AND ABSORPTION COEFFICIENTS OF NITROGEN DIOXIDE.
T.Nakayama, M.Y.Kitamura and K.Watanabe.
J. chem. Phys., Vol. 30, No. 5, 1180-6 (May, 1959).

Absorption coefficients of NO_2 were measured at a number of wavelengths in the spectral region 1080-2700 A with a resolution of 0.2 A by a photoelectric method. Several bands observed in the region 1080-1200 A fitted a Rydberg series, and its convergence limit at 11.62 eV was interpreted as the second ionization potential of NO_2. The first ionization potential was found to be 9.78 eV by the photoionization method. The ionization continuum showed a break at 10.83 eV which may be due to a probable dissociative-ionization process. Several other electronic transitions corresponding to discrete and continuous absorption are discussed.

537.561

7119. ON THE EFFECTIVE IONIZATION POTENTIAL OF ATOMS IN A PLASMA. O.Theimer.
Z. Naturforsch., Vol. 12a, No. 6, 518-19 (1957). In German.

The ionization potential is reduced in the presence of free ionization, as in a plasma, and this reduced potential is discussed briefly in terms of the Debye–Hückel theory and the more recent work of Ecker and Weizel and others. (See also following two abstracts).

J.D.Craggs

537.561

7120. SUM-OVER-STATES AND EFFECTIVE IONIZATION POTENTIAL INSIDE A PLASMA. G.Ecker and W.Weizel.
Z. Naturforsch., Vol. 12a, No. 10, 859-60 (1957). In German.

Clarification of an earlier paper by the authors (Abstr. 4425/1956). Criticizes an approximate evaluation of the electrostatic interaction energy of a plasma by Theimer (see preceding abstract) because it unjustifiably assumes stochastic independence of the charged particles. (See also following abstract).

B.Meltzer

537.561

7121. ON THE MUTUAL ENERGY EXCHANGE OF CHARGE CARRIERS IN A PLASMA. G.Ecker and W.Weizel.
Z. Naturforsch., Vol. 13a, No. 12, 1093-4 (Dec., 1958). In German.

(See also preceding two abstracts). The authors' expression for the calculation of effective ionization potentials (Abstr. 4425/1956) was criticized by Theimer (Abstr. 7119/1959). The authors reply to these criticisms on the basis of extensions to the Debye–Hückel theory.

C.G.Morgan

537.562

7122. MODEL WAVE FUNCTION STUDY OF NEGATIVE ION PHOTODETACHMENT IN OXYGEN. J.J.Brehm.
J. appl. Phys., Vol. 30, No. 3, 329-33 (March, 1959).

The total cross-section for O^- photodetachment is computed using an analytical model to give agreement with the data obtained by Branscomb, Smith, and Burch. For the calculation of the electric dipole matrix element single-electron wave-functions are constructed for the initial and final states which reflect the short range of the interaction between the neutral atom and the extra electron. These are written in terms of two parameters which are determined in order to fit the experimental data. The bound state parameter β gives an indication of the weak binding of the system and also gives a measure of the "size" of the ion. The continuum state parameter, the s-wave phase shift δ, gives the total cross-section for the low energy elastic scattering of electrons by O atoms.

537.563

7123. MASS SPECTROMETRIC STUDY OF Al_2O_3.
G.De Maria, J.Drowart and M.G.Inghram.
J. chem. Phys., Vol. 30, No. 1, 318-19 (Jan., 1959).

With an alumina liner inserted in a tungsten cell the following ions have been observed: O^+, O_2^+, Al^+, AlO^+, Al_2O^+, WO^+, WO_2^+, and WO_3^+, the ratio AlO^+/Al_2O^+ being close to 1. Small intensities of ions from impurities have also been noted. Over liquid Al_2O_3 at 2475°K the molecule Al_2O_2 was also observed. Its appearance potential was found to be essentially equal to that of AlO, its pressure to be about 1/200 that of AlO. The atomization energy for gaseous Al_2O_3 has been estimated to be 500 kcal/mole.

R.Schnurmann

537.563

7124. IONIZATION OF N-PARAFFIN MOLECULES.
N.D.Coggeshall.
J. chem. Phys., Vol. 30, No. 2, 595-6 (Feb., 1959).

The mass spectral patterns of n-paraffins do not agree with the predictions of molecular orbital theory. From theoretical considerations the most abundant ions would be those of approximately one-half the molecular weight of the parent molecule. Yet the experimental evidence from mass spectra of n-paraffins in the C_7 to C_{25} range is that the probability of C–C bond rupture is small for the bonds at the ends. It increases to a maximum for the third or fourth C–C bond from the ends and then decreases for bonds further from the ends.

R.Schnurmann

537.563

7125. MASS SPECTRUM OF ACETYLENE PRODUCED BY 5.1 MeV ALPHA PARTICLES. C.E.Melton and P.S.Rudolph.
J. chem. Phys., Vol. 30, No. 3, 847-8 (March, 1959).

The use of alpha-particles to produce ions in a mass spectrometer gives a much simplified mass spectrum as compared to the use of 75 eV electrons. This technique is therefore advantageous for analytical application.

R.Schnurmann

537.563

7126. PHOTOIONIZATION ANALYSIS BY MASS SPECTROSCOPY
G.L.Weissler, J.A.R.Samson, M.Ogawa and G.R.Cook.
J. Opt. Soc. Amer., Vol. 49, No. 4, 338-49 (April, 1959).

A vacuum ultraviolet monochromator was combined with a mass spectrometer to study photoionization processes between 1570 and 430 A. Monochromatic photons were used to ionize, A, He, Ne, O_2, N_2, CO, NO, CO_2, N_2O, and NO_2; and preliminary measurements of ion intensity as a function of photon energy were obtained for the parent ions together with their fragments. The appearance of ionization and the structure of curves, in which ions per unit photon flux v. λ are plotted, will be related to previously reported energy levels to photoionization cross-sections, and to dissociative photoionization mechanisms.

537.564 : 539.19

7127. NEGATIVE ION FORMATION BY AN ELECTRON CAPTURE PROCESS IN NITRIC OXIDE. DISSOCIATION ENERGY OF THE NITRIC OXIDE MOLECULE. D.C.Frost and C.A.McDowell. J. chem. Phys., Vol. 29, No. 6, 1424-5 (Dec., 1958).

The application of recent techniques to study the production O^- ions from nitric oxide is described. The value of 6.34 eV deduced for the dissociation energy of NO is in good agreement with recent spectroscopic evidence. G.I.W.Llewelyn

537.564

7128. ATTACHMENT OF LOW-ENERGY ELECTRONS IN MIXTURES CONTAINING OXYGEN. G.S.Hurst and T.E.Bortner. Phys. Rev., Vol. 114, No. 1, 116-20 (April 1, 1959).

Electron attachment to O_2 was studied for O_2-N_2 and $O_2-C_2H_4$ mixtures over a wide range of pressures and electric fields. It was found that α, the probability of capture per cm and per mm Hg of O_2, depends on the partial pressures of both gases in the O_2-N_2 mixture but only on the C_2H_4 pressure in the $O_2-C_2H_4$ mixture. The data are interpreted in terms of an extension of the mechanism postulated by Bloch and Bradbury, and by Bates and Massey, which involves first the formation of O_2^{-*} (excited by O_2^-) with subsequent collisional stabilization. On this basis estimates were made of the cross-section for stabilization of O_2^{-*} by collisions with various kinds of molecules.

537.568

7129. MASS-SPECTROMETRIC INVESTIGATION OF THE REACTION $X^+ + H_2 \rightarrow HX^+ + H$. H.Gutbier. Z. Naturforsch., Vol. 12a, No. 6, 499-507 (1957). In German.

It was found that the rate of formation of HX^+ (where X is He, Ne, A, Kr, N_2, O_2 or CO_2) is proportional to concentrations of H_2 and X^+ and inversely proportional to the velocity of X^+ ions. For the mean kinetic energy of the ions, amounting to $E_{kin} = 0.25$ eV, the measured cross-sections are of the order of magnitude of 10^{-15} cm^2. F.Lachman

537.568 : 539.18

ELECTRON RECOMBINATION IN ATOMIC HYDROGEN. See Abstr. 6162

537.57 : 538.3

DIFFUSION OF MAGNETIC FIELDS IN A CYLINDRICAL CONDUCTOR. See Abstr. 5957

537.57 : 539.19

7130. COLLISION CROSS-SECTION STUDIES ON MOLECULAR GASES AND THE DISSOCIATION OF OXYGEN AND WATER. E.N.Lassettre.
Radiation Research, Suppl. No. 1, 530-46 (1959). See Abstr. 5164 (1959).

Gives a general review, with a theory of scattering, of an experimental programme of work on electron scattering. An apparatus is described which enables velocity analysis on the scattered electrons, for a variable scattering angle, to be made. Results are shown for helium and oxygen. Collision cross-sections, oscillator strengths and dissociation (of water and oxygen) are also briefly discussed. J.D.Craggs

COSMIC RAYS

537.591 : 539.1.07

HIGHLY DIRECTIONAL DETECTOR FOR COSMIC RAY PARTICLES. See Abstr. 5973

537.591.1

7131. AN EXPERIMENTAL ANALYSIS OF TWO LARGE COSMIC RAY JETS. F.A.Brisbout and C.B.A.McCusker.
Nuovo Cimento, Vol. 11, No. 4, 484-95 (Feb. 16, 1959).

The true primary energy of two large jets has been estimated from a study of the secondary interactions and the electromagnetic cascades resulting from the decay of π^0-mesons. This is compared with the energy estimated from $\gamma_p = 2/\mathrm{tg}^2\eta$ and found, in both cases, to be much greater. However, good agreement with the estimate of primary energy obtained using the tunnel theory of jets is found.

537.591.1

7132. LITHIUM, BERYLLIUM, AND BORON IN THE PRIMARY COSMIC RADIATION. P.S.Freier, E.P.Ney and C.J.Waddington. Phys. Rev., Vol. 113, No. 3, 921-7 (Feb. 1, 1959).

In order to resolve the controversy concerning the abundance of the light elements ($3 \leq Z \leq 5$) in the primary cosmic radiation, a further experiment was performed. The charge spectrum of the cosmic radiation was determined on October 19, 1957 in a stack of nuclear emulsions exposed nearer the top of the atmosphere than before. The results of the experiment prove that these light elements make up an appreciable fraction of all those nuclei with $Z \geq 3$ present in primary cosmic radiation. The flux values found after correction to the top of the atmosphere are, in particles/m^{2}sec sterad:

Li, Be, B (L nuclei)	1.9 ± 0.3
CNOF (M nuclei)	5.1 ± 0.5
Z ≥ 10 (H nuclei)	1.7 ± 0.3

These values appear to be lower than observed previously in agreement with the decrease in the α-particle flux associated with the sun's increased activity.

537.591.15 : 523.745

7133. FURTHER STUDIES OF COSMIC RAY BURSTS WITH SOLAR ACTIVITY. S.L.Malurkar.
Acta phys. Hungar., Vol. 9, No. 4, 353-68 (1959).

Among the upper air observations of cosmic-ray intensity, Pomerantz (Abstr. 4481/1956), after a preliminary choice, selected nine instances to relate to solar flares, giving corresponding radio data and reproducing the cosmic ray records. As these were events described in some detail, it was considered desirable to examine them with reference to the evolution of corresponding solar active regions. As the evolution of the region was considered, the use of available solar magnetic data previous and subsequent to the actual flares would not be objectionable. Solar magnetic data were also available for one of the five very large solar flares connected with cosmic ray bursts and allowed good comparison. The examination has not indicated any modification of the conclusions drawn earlier.

537.591.15

7134. AIR SHOWERS OF SIZE GREATER THAN 10^5 PARTICLES IV. THE DISTRIBUTION OF NUCLEAR-ACTIVE PARTICLES AND OF MU-MESONS. J.A.Lehane, D.D.Millar and M.H.Rathgeber. Nature (London), Vol. 182, 1699-704 (Dec. 20, 1958).

For Pt III, see Abstr. 2464 (1959). This was determined for showers of size from 3×10^4 to 6×10^6 charged particles, for distances from the shower core up to 50 m. No significant dependence of the form of the distribution on shower size was found. On the (therefore reasonable) assumption of a constant form for the radial structure function, the number of μ-mesons in the showers is found to vary as $N^{0.4 \pm 0.1}$, while the number of nucleons varies as $N^{0.6 \pm 0.1}$. Comparison with similar experiments at mountain altitudes indicates, also on this assumption, that the attenuation lengths of nucleons and of μ-mesons are longer in small showers than in large. Comparison with theory gives a value 0.3 for the inelasticity of the high energy collisions in the nucleon cascade. It is suggested that the experimental position is now sufficiently clear for extended theoretical computations to be worthwhile. R.H.W.Johnston

537.591.15

7135. INDEX OF THE ENERGY SPECTRUM OF THE PENETRATING COMPONENT IN EXTENSIVE AIR SHOWERS WITH A SPECIFIED NUMBER OF PARTICLES.
R.E.Kazarov and É.L.Andronikashvili.
Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1528-30 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1182-3 (June, 1957).

A study at 400 m elevation using absorber (earth) thicknesses of 61, 127 and 162 m water equivalent. The spectrum at a mean distance of 28 m from the shower axis was given by $\rho = Ae^{-\gamma}$ with $\gamma = 1.09 \pm 0.21$, where ρ is density of penetrating particles. The mean number of particles in a shower was 2.9×10^5. C.J.Batty

537.591.2

7136. FLUX AND ENERGY SPECTRUM OF COSMIC-RAY α-PARTICLES DURING SOLAR MAXIMUM.
P.S.Freier, E.P.Ney and C.J.Waddington.
Phys. Rev., Vol. 114, No. 1, 365-73 (April 1, 1959).

The fluxes of primary cosmic-ray α-particles over Minnesota and Texas were measured during the present period of maximum solar activity. A value of 136 ± 9 α-particles/m² sec sterad was measured over Minnesota and of 68 ± 4 α-particles/m² sec sterad over Texas. In both cases these values are significantly lower than those observed at solar minimum. The energy spectrum of these particles was determined between 200 MeV/nucleon and 3.0 BeV/nucleon. It is shown that the slope of the integral spectrum is less than that observed at solar minimum and that a significant number of low-energy particles is still present. A possible mechanism for these changes is discussed briefly. The determination of energies of particles from a measurement of their ionization is discussed in detail in an appendix.

537.591.2

7137. MOMENTUM SPECTRUM OF COSMIC RADIATION. H.Alfvén.
Tellus, Vol. 11, No. 1, 106-15 (Feb., 1959).

If in a variable magnetic field charged high energy particles are injected at a certain point, they are accelerated but at the same time they diffuse outwards from the point of injection. Near the point of injection the density in a volume element of six-dimensional phase-space is increased by the acceleration process but decreased by the diffusion, and the momentum spectrum is obtained from the stationary state when these two effects are equal. The theory gives two expressions for the power spectrum, in which the value of the exponent depends in a very insensitive way on the rate of acceleration and the rate of diffusion. The spectrum depends on the distance from the source of injection and the average energy density is orders of magnitude smaller than the density near the source of injection. The theory is in agreement with the "local" theory of Cosmic Radiation, but it is difficult to reconcile it with galactic or extragalactic theories.

537.591.5

7138. TRANSIENT DECREASES IN COSMIC RAY INTENSITY DURING THE PERIOD OCTOBER 1956 TO JANUARY 1958. A.G.Fenton, K.G.McCracken, D.C.Rose and B.G.Wilson.
Canad. J. Phys., Vol. 37, No. 5, 569-78 (May, 1959).

Recent nucleon intensity data obtained from high counting rate recorders at Ottawa and Hobart and subsidiary stations, have been examined for evidence for the superposition of transient decreases. It is concluded that, with the statistical accuracy now available due to the high counting rates, it is possible to distinguish two types of transient decrease in the observed variations, superimposed upon the slower 11-year intensity changes. One of these is an almost symmetrical event lasting up to 2 weeks and exhibiting a recurrence tendency of about 27 days, while the other is the more abrupt Forbush decrease which recovers over a period of several days. The evidence indicates that the intensity-controlling mechanism responsible for these short-term transient changes is able to influence the cosmic ray flux at the earth independently of other events that may be in progress at the time. There is also evidence that the physical process controlling the Forbush type of decrease operates over a volume large compared with the earth because the intensity changes at places as far apart as Ottawa, Canada, and Hobart, Tasmania, show changes that are the same within the accuracy of the measurements.

537.591.5 : 550.389

7139. WORLD-WIDE DISTRIBUTION OF COSMIC-RAY NEUTRON INTENSITY AT SEA LEVEL. M.Kodama.
J. Geomagn. Geoelect., Vol. 10, No. 2, 37-46 (1959).

The distribution was mapped from an analysis of eight latitude surveys carried out between 1937 and 1957. The contour map thus obtained was compared with the various models for the earth's geomagnetic field.

537.591.5

7140. MULTIPLE GEIGER TELESCOPE MEASUREMENTS OF THE DIRECTIONS OF AIR SHOWER PARTICLES. H.D.Rathgeber.
Nature (London), Vol. 183, 386-7 (Feb. 7, 1959).

The performance of a multiple Geiger telescope has been examined in conjunction with a scintillator array sensitive to the total number of particles, core situation, and direction of axis of cosmic ray extensive air showers. It is found that such telescopes do not select in larger proportion air showers of preferred orientation. E.W.Kellermann

537.591.5 : 551.590.21

7141. COSMIC RADIATION AND THE WEATHER. E.P.Ney.
Nature (London), Vol. 183, 451-2 (Feb. 14, 1959).

Ground level and balloon measurements of cosmic ray atmospheric ionization over the last two solar cycles show that there is a marked inverse correlation with solar activity at all levels. It is speculated that decreased atmospheric ionization (at sunspot maximum) might lead to increased thunderstorm activity and cloud cover, and hence lower atmospheric temperatures. G.M.Brown

537.591.5

7142. LONG TERM CHANGES IN THE DAILY VARIATION OF COSMIC RAY INTENSITY. D.Venkatesan and A.Dattner.
Tellus, Vol. 11, No. 1, 116-29 (Feb., 1959).

Cosmic-ray measurements at different stations for the period 1937-55 are analysed. The diurnal variation is found to be a world-wide phenomenon, thus giving the anisotropy of the primary radiation and its correlation with solar and geomagnetic activities.

537.591.8 : 539.17

7143. INTERACTIONS OF THE HEAVY NUCLEI OF COSMIC RAYS IN CARBON. Y.Hirashima.
Nuovo Cimento, Vol. 12, No. 1, 1-15 (April 1, 1959).

The fragmentation probabilities of the heavy nuclei of cosmic rays have been investigated in carbon. Emulsion chambers consisting of carbon plates between nuclear emulsions exposed in Japan ($\lambda = 25^\circ$N) were used. The charges of the heavy nuclei with $Z \geq 3$ were determined by measuring the δ-ray densities. The fragmentation probabilities into the light nuclei are $P_{HL} = 0.35 \pm 0.08$ and $P_{ML} = 0.35 \pm 0.08$. The abundances at the balloon flight altitudes observed by several groups were extrapolated to the top of the atmosphere by using the fragmentation probabilities in carbon obtained in the present work. The ratio of the light nuclei to the medium nuclei at the top of the atmosphere is probably in the range from ~ 0.1 to ~ 0.2

MAGNETISM

MAGNETIC RESONANCES

538.07

7144. A ROTATING PROBE FOR MEASURING THE INHOMOGENEITY OF A MAGNETIC FIELD. J.Kaczér and Z.Málek.
Czech. J. Phys., Vol. 7, No. 4, 481-8 (1957).

The theory, design, calibration and sensitivity of the instrument are presented. Some applications such as the measurement of saturation magnetization, the Curie point and hysteresis loops, are discussed.

538.08

7145. EQUIPMENT FOR THE DETERMINATION OF MAGNETIC SUSCEPTIBILITIES. J.A.McMillan.
Amer. J. Phys., Vol. 27, No. 5, 352-4 (May, 1959).

Equipment for the determination of magnetic susceptibilities by the Gouy method utilizing an electromagnet and a Westphal specific gravity balance is described. Using Mohr's salt as a standard, the paramagnetism of salts like pentahydrated copper sulphate can be determined within 4%. The diamagnetism of some substances, such as water, can also be measured to one significant figure. Experimental results are given.

538.08 : 537.54

7146. ACCURATE MAGNETIC FIELD AND FIELD GRADIENT MEASURING INSTRUMENT FOR DYNAMIC LOW FIELDS IN A SYNCHROTRON MAGNET. H.M.Nysäter.
Nuclear Instrum., Vol. 4, No. 1, 44-9 (Jan., 1959).

Two biased peaking strips are combined into a differential magnetic probe. The pulses from the two peaking strips are displayed on an oscilloscope screen with a time separation, for the same bias field, given by the field difference between the locations of the two strips. At the bias current corresponding to the chosen field level, the two peaking strips are given slightly different bias, so as to cancel the time lag between pulses. The field difference is read directly as a d.c. current. The magnetic field itself is measured with one of the peaking strips, as its d.c. bias current. With careful calibration, the accuracy in gradient divided by field (n-value) was estimated to be of the order of 1% in a nearly linear synchrotron field of 25 G, varying by 4% per cm and 0.15 G/μs. The instrument, when applied to the Cambridge (Mass.) electron accelerator magnet confirmed the feasibility of an injection field as low as 25 G, althoug at the magnet ends sharp peaks occur in the field and gradient distributions, apparently a remanent field contribution.

538.1 : 550.839

7147. FIELD OF AN ALTERNATING MAGNETIC DIPOLE ON THE SURFACE OF A LAYERED EARTH.

L.B.Slichter and L.Knopoff.
Geophysics, Vol. 24, No. 1, 77-88 (Feb., 1959).

The magnetic field near a vertical alternating magnetic dipole on the surface of a layered earth is computed for points on the surface. In the layer, the dimensionless conductivity parameter is assumed to take the values 0, $\frac{1}{4}$, 1, and 4; in the homogeneous substratum, this parameter is assigned the values 0, $\frac{1}{4}$, 1, 4, and infinity. The induced field is computed at distances from the source $\frac{1}{2}$, 1, 2, 4, 8, and 16 times the layer thickness.

538.1 : 621.318.3

7148. ON A METHOD OF PRODUCING STRONG MAGNETIC FIELDS OF SHORT DURATION.

A.Piekara and J.Małecki.
Acta phys. Polon., Vol. 15, No. 6, 381-8 (1956).

A method is described of producing strong magnetic fields of the order of 50 μsec duration, using a 2 μF capacitor charged to 50 kV. The problem of making a mechanically resistant coil is discussed. A method is given of measuring the field intensity with a search coil connected to a c.r.o. The fields attained intensity up to 350 000 Oe in a volume of about 1 cm^3.

538.1 : 621.318.433

7149. AIR-CORED COILS FOR THE PRODUCTION OF VERY STRONG CONSTANT MAGNETIC FIELDS. CALCULATIONS AND APPLICATIONS. III. CONSTRUCTION OF THE COILS.

F.Gaume.
J. Rech. Cent. Nat. Rech. Sci., No. 45, 287-303 (Dec., 1958).
In French.

For Pt I-II, see Abstr. 4773-4 (1959). The following are considered: cooling the windings; making the connections; variation of current density at various points of the coil; arrangement of the conductors, with special reference to their protection from the action of e.m. forces. A laboratory-constructed coil is described, and a winding is recommended which has certain special advantages. The main results established in Parts I-III are summarized.

538.2

7150. REMARKS ON MAGNETICALLY DILUTE SYSTEMS.

H.Sato, A.Arrott and R.Kikuchi.
J. Phys. Chem. Solids, Vol. 10, No. 1, 19-34 (April, 1959).

Because of the inadequacies of previous treatments of the magnetic properties of magnetically dilute systems when used to interpret experimental results, a re-examination of the problem starting from a simple model is made. The treatments of the problem discussed here, using an Ising model, show that a Curie or a Neel temperature does not appear until a finite concentration of magnetic atoms is obtained if the atomic distribution is random. This concentration depends on the coordination number of the lattice and on the range of interaction, but not on the strength of the interaction. The results given here for nearest-neighbour interactions describe the general behaviour observed in magnetically dilute solutions. Such things as anomalously high values of "effective magnetic moments" per magnetic atom and its concentration-dependence, curvature in inverse susceptibility against temperature plots, and parasitic paramagnetism in the weakly ferromagnetic alloys, etc., are reasonably well explained. When the system has antiferromagnetic interactions, it is found that the inverse susceptibility shows a complicated temperature-dependence varying with concentration and that the existence of a maximum in the susceptibility does not necessarily mean the onset of antiferromagnetism. Special references are made to iron in gold and chromium and to manganese in copper.

538.2

7151. INTERPRETATION OF THE LAW OF MAGNETIZATION OF THE ION Yb^{+++} IN THE GARNET-TYPE GALLATE.

Y.Ayant and J.Thomas.
C.R. Acad. Sci. (Paris), Vol. 248, No. 3, 387-9 (Jan. 19, 1959).
In French.

The spin Hamiltonian for the ion in a cubic field is diagonalized and the magnetization at low temperatures calculated from a consideration of the two lowest energy levels. The calculated variation of the magnetization with H/T is in good agreement with observation.

E.P.Wohlfarth

538.2

7152. THE MAGNETIC SUSCEPTIBILITY OF SILVER–MANGANESE SOLID SOLUTIONS BETWEEN 100°K AND 500°K.

D.P.Morris and I.Williams.
Proc. Phys. Soc., Vol. 73, Pt 3, 422-32 (March, 1959).

The magnetic susceptibility of Ag–Mn solid solutions containing between 4.44 and 38.1 at.% Mn has been measured between 100 and 500°K. Alloys containing less than 20 at.% Mn obey a Curie–Weiss law and the p_{eff} values derived for the Mn atoms are discussed and compared with other published values for this system. Over the range 7-20 at.% the (p_{eff}, Mn concentration) curve is linear, indicating a $3d^5 4s^2$ configuration for the Mn atoms at infinite dilution. The authors' and some other published values for more dilute alloys are however not in good agreement with a linear extrapolation. Examination of published data shows that a similar discrepancy between dilute and more concentrated alloys exists in Cu–Mn solid solutions. No explanation of such an effect can yet be advanced, but the sensitivity of the p_{eff} values to the diamagnetic correction in very dilute alloys is pointed out, as well as a difference between electronic configurations deduced from susceptibility and from electron spin resonance measurements. Beyond 20 at.% Mn the Ag–Mn alloys no longer obey a Curie–Weiss law and the possibility of short-range magnetic order in them is discussed. Some comparisons are drawn between the solid solutions of Mn in Cu, Ag and Au.

538.2

7153. PARAMAGNETIC SUSCEPTIBILITIES OF THE CHROMIUM (III) HALIDES.

W.N.Hansen and M.Griffel.
J. chem. Phys., Vol. 30, No. 4, 913-16 (April, 1959).

The paramagnetic susceptibilities of CrF_3, $CrCl_3$, $CrBr_3$, and CrI_3 were measured by the Gouy method from room temperature down to a temperature at which the susceptibility is field-dependent. Above approximately 100°K these susceptibilities all obey the Curie–Weiss law with respective constants as follows: θ(°K) = −124, 31, 51, and 70; P_{eff} (Bohr magnetons) = 3.85, 3.69, 3.94, and 4.03. CrF_3 evidently becomes ferrimagnetic below 70°K.

538.2

7154. EXCLUDED-VOLUME PROBLEM AND THE ISING MODEL OF FERROMAGNETISM.

M.E.Fisher and M.F.Sykes.
Phys. Rev., Vol. 114, No. 1, 45-58 (April 1, 1959).

The relationship between the excluded-volume problem for a discrete random walk on a lattice and the corresponding Ising model of ferromagnetism is investigated. Systematic methods are presented for the construction of rigorous lower bounds to the limit $\mu = \lim_{n\to\infty}(c_{n+1}/c_n)$, where c_n is the number of n-step self-avoiding walks on a given lattice. In this way Temperley's conjecture that $\mu = \coth(J/kT_c)$, where T_c is the Curie temperature of the corresponding Ising-model ferromagnet, is disproved. The series c_n for various two- and three-dimensional lattices are enumerated exactly for values of n from 10 to 20. Extrapolation of these series, by procedures known to be valid from exact Ising-model results, yields more accurate values of μ than Wall's statistical calculations and also shows that $c_n \sim n^{\alpha}\mu^n$ where $\alpha \cong \frac{1}{3}$ for plane lattices and $\alpha \cong \frac{1}{7}$ for three-dimensional lattices. This means that the entropy of the n-th "link" of a polymer molecule in solution should vary as $\delta S_n = k \ln \mu + k\alpha/n$. The relevance of these results to the interpretation of the boundary tension of the Ising model, to the critical behaviour of gases, and to the mean square size of a polymer molecule is discussed briefly.

538.2 : 537.312.8

7155. SPIN–ORBIT COUPLING AND THE EXTRAORDINARY HALL EFFECT.

C.Strachan and A.M.Murray.
Proc. Phys. Soc., Vol. 73, Pt 3, 433-47 (March, 1959).

In general terms a qualitative account of the extraordinary Hall effect in ferromagnetic media may be based on spin–orbit coupling. The magnitude of the effect produced is, classically, very sensitive to the actual path of the electron, or, quantum-mechanically, to some of the detail of its wave-function. Here conventional quantum-mechanical transport theory is used in some quantitative detail to evaluate the actual magnitude of the extraordinary Hall coefficient R_S. The initial states of electrons after collisions with the lattice are assumed to be superposition of Bloch functions with random phases. Bloch functions for the s- and d-bands of nickel are chosen in sufficient detail to make possible a numerical calculation. It is found that R_S/ρ^2, where ρ is the resistivity, increases very slightly for the pure metal with increasing temperature. At 290°K, R_S is found to be slightly less than -2×10^{-12} ohm cm gauss^{-1}.

538.2

7156. COOPERATIVE MAGNETISM IN OXIDE STRUCTURES. I. ANTIFERROMAGNETISM AND FERROMAGNETISM.

L.C.F.Blackman.
Research, Vol. 12, No. 5, 164-71 (May, 1959).

A discussion of the antiferromagnetic and ferromagnetic properties of certain oxide systems. A brief account is given of the current theories of indirect magnetic exchange interaction.

538.2 : 539.2

MAGNETIC SUSCEPTIBILITY OF A FERROUS AMMONIUM SULPHATE SINGLE CRYSTAL AT VERY LOW TEMPERATURES.

See Abstr. 6259

538.2

7157. MAGNETOCRYSTALLINE ANISOTROPY CONSTANT OF 3.1% Si–Fe AT ROOM TEMPERATURE AND BELOW.

C.D.Graham, Jr.
J. appl. Phys., Vol. 30, No. 3, 391-2 (March, 1959).

The first crystal anisotropy constant of a 3.1% Si–Fe alloy has been determined from torque measurements on a {100} single-crystal disk, in fields up to 20 000 oersteds and at temperatures of 77, 195, and 300°K. The values of K_1 at these three temperatures are 425 ± 10 × 10^3, 405 ± 10 × 10^3 and 365 ± 10 × 10^3 ergs/cm^3.

538.2

7158. MAGNETOCRYSTALLINE ANISOTROPY CONSTANTS OF IRON AT ROOM TEMPERATURE AND BELOW. C.D.Graham, Jr.

Phys. Rev., Vol. 112, No. 4, 1117-20 (Nov. 15, 1958).

The anisotropy constants of iron were determined from torque measurements on a (110) single-crystal disk in fields up to 15 000 Oe or higher and at temperatures of 77, 195 and 300°K. The values of K_1 at the three temperatures are (520 ± 10) × 10^3, (505 ± 10) × 10^3, and (480 ± 10) × 10^3 ergs/cm^3; the value of K_2 at all three temperatures is (0 ± 50) × 10^3 ergs/cm^3. The anisotropy decreases as the fourth power of the saturation magnetization over the temperature range studied.

538.2

7159. MAGNETIC PERMEABILITY FOR MAGNETIZATION BY A ROTATING ALTERNATING FIELD IN THE PRESENCE OF A LONGITUDINAL DIRECT FIELD. V.Tutovan.

C.R. Acad. Sci. (Paris), Vol. 248, No. 7, 940-3 (Feb. 16, 1959).
In French.

The permeability, defined as the ratio of induction to alternating field strength H_a, was measured for a wire specimen as a function of H_a, the strength of the direct field and the applied stress.

E.P.Wohlfarth

538.2

7160. ON THE DOMAIN STRUCTURE OF THIN FERROMAGNETIC FILMS. J.Kaczér.

Czech. J. Phys., Vol. 7, No. 5, 557-67 (1957).

The energy of Bloch walls is calculated with respect to the demagnetizing energy of a Bloch wall. A model of the stability of the domain structure in thin films is proposed.

538.2

7161. DOMAIN BEHAVIOR IN SOME TRANSPARENT MAGNETIC OXIDES. R.C.Sherwood, J.P.Remeika and H.J.Williams.

J. appl. Phys., Vol. 30, No. 2, 217-25 (Feb., 1959).

Magnetic domains were observed by means of the Faraday effect. and by the Bitter technique in a number of compounds having the spinel, magnetoplumbite, and perovskite-like structures. The latter compounds are orthorhombic and have the general formula $MFeO_3$ where M is Y, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, or Lu. Domain boundaries in these compounds move for fields less than 1 Oe, and after saturation, crystals as large as (~0.2 × 0.2 × 0.1 in.) remain single domains. Fields of 2500 Oe are required to reverse the magnetization in the single domain crystals. Reversal occurs by nucleation and growth of a reverse domain. This is evident from the unusual torque curves. The fact that domain walls occur and move in such weak fields in these compounds indicate that the slight or parasitic magnetization is a uniform body property of the crystals. The parasitic magnetization of these compounds was determined from torque measurements. These crystals are well suited for light modulators because a uniaxial anisotropy holds the magnetization vectors normal to the large surfaces of thin flat crystals and weak fields produce changes in magnetization. Absorption coefficients were measured for some compounds for radiation having wavelengths from 0.6 to 13 μ. Thin sections were found to be transparent to light at the red end of the visible spectrum. The Faraday rotation was measured for $Li_{0.5}Fe_{2.5}O_4$, $MgFe_2O_4$; $YFeO_3$, and $PbFe_{11}Al_1O_{19}$.

538.2

7162. DOMAIN BOUNDARY CONFIGURATIONS DURING MAGNETIZATION REVERSALS. J.J.Becker.

J. appl. Phys., Vol. 30, No. 3, 387-90 (March, 1959).

The signal resulting from the application of an alternating field while a magnetization reversal is taking place yields information about the total domain boundary area contributing to the reversal at each moment. This technique is used to show that the variation in rate during a reversal in a 65 Permalloy tape core corresponds to changes in the area of moving domain boundary, whereas in a 3¼% silicon-iron single crystal picture frame specimen the area of moving domain boundary remains approximately constant, and variations in reversal rate therefore correspond to variations in velocity.

538.2 : 548.74

7163. EXTINCTION EFFECTS IN NEUTRON SCATTERING FROM SINGLE MAGNETIC CRYSTALS. W.C.Hamilton.

Acta cryst., Vol. 11, Pt 9, 585-94 (Sept., 1958).

Results arising from treatment of the magnetic scattering of neutrons, taking due account of the possibility of polarization of the neutron beam, indicate that the usual expressions for primary and secondary extinction must be modified in certain cases. Extinction, particularly primary extinction, will be generally more severe for reflections which have both nuclear and magnetic contributions than for either pure nuclear or pure magnetic reflections. Formulae and curves are presented for primary and secondary extinction corrections which are applicable to both magnetized and unmagnetized ferromagnetic or antiferromagnetic crystals. Some of the results obtained may be conveniently used to determine relative amounts of primary and secondary extinction, and consequently both mosaic block size and angular distribution. Many of the calculations are of interest in predicting the effects of extinction on experiments designed either to produce or use polarized neutron beams. The precession of the neutron polarization axis about the magnetic axis can affect the reflected intensity if extinction is severe. This effect is discussed briefly and is shown to be serious only for magnetized crystals. The paper also discusses the necessary changes in the scattering formulae if all the spins in the unit cell do not lie along a unique magnetic axis.

538.2 : 537.533

ELECTRON POLARIZATION MICROSCOPY IN STUDY OF MAGNETIC MATERIALS.

See Abstr. 7082

538.2

7164. ON THE MAGNETIC PROPERTIES OF THIN ELECTROLYTICALLY DEPOSITED NICKEL FILMS. W.Ruske.

Ann. Phys. (Leipzig), Folge 7, Vol. 2, No. 5-6, 274-86 (1958).
In German.

A recording fluxmeter was used to obtain hysteresis loops for a large number of electrolytically deposited nickel films of thickness between 20 and 2 × 10^3 A. The object of the work was to determine the effect of film thickness on magnetic properties when the influence of other factors — structure, strain, etc. — had been eliminated.

A.E.De Barr

538.2

7165. THIN MAGNETIC FILMS. R.S.Webley.

Nature (London), Vol. 183, 999-1000 (April 4, 1959).

Films of nickel—iron alloys were prepared by evaporation on to glass, and the low frequency hysteresis loop observed during the preparation. As the thickness increased from 150 to 1500 A the coercivity remained constant at 1-2 Oe, and it then either increased suddenly to 10-20 Oe, or decreased slowly to 0.5 Oe as the evaporation continued. Different behaviour was observed when other substrate materials were used.

C.Hilsum

538.2

7166. FORM EFFECT IN LINEAR MAGNETOSTRICTION.

H.E.Stauss.
J. appl. Phys., Vol. 30, No. 5, 698-701 (May, 1959).

The influence of the shape of the specimen upon the measured value of magnetostriction is a matter of importance. The classical thermodynamical calculation of Becker applies to specimens in like magnetic fields and consequently compares bodies with unlike intensities of magnetization. In the present paper use is made of the principle of virtual work to make a calculation of the form effect as dependent upon the intensity of magnetization. The form effect for an ellipsoid in an extended uniform field is found to be a constrictive strain of the magnitude

$$\Delta A_{11} = \frac{-(1-2\mu)}{E} \; \frac{NI^2}{2},$$

where ΔA_{11} is the form effect in strain, μ is Poisson's ratio, E is Young's modulus, N is the coefficient of self-demagnetization, and I the intensity of magnetization. Above saturation the form effect is

$$\Delta A_{11} = -\frac{(1-2\mu)}{E} \; \frac{NI_s^2}{2}.$$

where Is is the saturation value of I. The meaning of the term form effect has been expanded to include not only the change in strain in the specimen resulting from the shape of the specimen itself, but also the change resulting from the position of the specimen relative to the magnetizing apparatus. A calculation of the form effect in this extended sense is made for two useful experimental arrangements; one where a specimen is sandwiched between two movable rods and the other where the specimen is situated in the fixed gap of a magnet. For the first case it is found that the form effect depends upon the self-demagnetization of the entire ferromagnetic arrangement and not of the specimen itself. In the second case, the form effect is dependent upon the ratio of gap energy to the volume of the ferromagnetic system and can be small, subject to the qualification that the form effect does not include the effects of any stresses that develop within the gap.

538.2

7167. TIME CHANGE OF PERMEABILITY AND HYSTERESIS LOOP DUE TO DIFFUSION AFTER-EFFECT IN FERROMAGNETICS.

M.Ōno.

Mem. Fac. Engng Nagoya Univ., Vol. 9, No. 1, 186-93 (May, 1957).

The results of observations on 4.16% silicon—iron, both in the completely stabilized state and also immediately after demagnetization, are reported for alternating fields up to 150 milli-oersteds. The hysteresis properties were obtained experimentally as loops representing the difference between B and μH were $\mu = B_m/H_m$. Rayleigh's law was confirmed only for measurements made immediately after demagnetization. The results are interpreted on Neel's theory of diffusion after-effect with the aid of a Preisach diagram.

A.J.Manuel

538.2

7168. FINE IRON FILAMENTS MAGNETS.

F.P.Levi.

Nature (London), Vol. 183, 1251-2 (May 2, 1959).

Outlines a technique for obtaining parallel, equally spaced filaments of iron, to obtain high coercive force. Results obtained are shown graphically.

E.G.Knowles

538.2

7169. TWO HALL EFFECTS OF IRON—COBALT ALLOYS.

F.P.Beitel, Jr and E.M.Pugh.

Phys. Rev., Vol. 112, No. 5, 1516-20 (Dec. 1, 1958).

The Hall coefficients and the resistivity of Fe—Co alloys were measured at 77°K, 169°K, and room temperature using fields up to 3.3 webers/m^2. For up to 0.2% Co in Fe the ordinary Hall coefficient R_0 is positive at room temperature but becomes negative at low temperatures; for all other composition R_0 is negative. Analysis with a simple model in which the (4s) conduction band consists of a parallel and an antiparallel sub-band shows that, for up to 20% Fe in Co, the parallel 3d sub-band is filled. It then empties as the Fe content increases, having about 0.2 holes per atom at 50% Fe, but at 65% Fe the bands apparently shift so that again the parallel 3d sub-band is filled. These conclusions remain unchanged if the analysis is based instead upon a model proposed recently in which the 3d electrons may be in nonconducting states as well as in the usual conducting-type states. The extraordinary Hall coefficient R_1 is positive for less than 25% Co in Fe, but for all other compositions it changes from positive to negative as the temperature decreases from 300°K to 169°K. R_1 and the resistivity ρ satisfy the relation $R_1 = a + b\rho^2$.

538.2

7170. THE FIELD DEPENDENCE OF THE MAGNETIZATION OF UNIAXIAL SUBSTANCES; APPLICATION TO $BaO{\cdot}6Fe_2O_3$.

V.S.Giron and R.Pauthenet.

C.R.Acad. Sci. (Paris), Vol. 248, No. 7, 943-6 (Feb. 16, 1959). In French.

The law of approach to saturation for rotational magnetization changes is derived, including terms in H^{-2} and H^{-3}. Interactions between grains and the effect of a finite second order anisotropy constant are also considered. Application is made to barium ferrite whose anisotropy field is in this way found to be 1.6×10^4 Oe.

E.P.Wohlfarth

538.2

7171. MAGNETIC MOMENTS OF ALLOYS AND COMPOUNDS OF IRON AND COBALT WITH RARE EARTH METAL ADDITIONS.

E.A.Nesbitt, J.H.Wernick and E.Corenzwit.

J. appl. Phys., Vol. 30, No. 3, 365-7 (March, 1959).

In order to determine whether ferromagnetic or antiferromagnetic exchange coupling would result from alloying the rare earth metals with cobalt or iron, a number of melts were made containing these elements. The data on saturation magnetization with composition and on saturation magnetization with temperature obtained on the cobalt-gadolinium system indicates strongly that antiferromagnetic exchange coupling exists in this system.

538.2

7172. MAGNETIC SUSCEPTIBILITY OF MANGANESE SESQUIOXIDE AT TEMPERATURES FROM 4 TO 700°K.

R.G.Meisenheimer and D.L.Cook.

J. chem. Phys., Vol. 30, No. 2, 605-6 (Feb., 1959).

Manganese sesquioxide is shown to be an antiferromagnetic material with a Curie point of about 80°K, following the Curie—Weiss law above 300°K. Results are briefly compared with previously recorded data.

G.I.W.Llewelyn

538.2

7173. NEUTRON-DIFFRACTION STUDY OF ANTIFERROMAGNETIC $FeTiO_3$ AND ITS SOLID SOLUTIONS WITH α-Fe_2O_3.

G.Shirane, S.J.Pickart, R.Nathans and Y.Ishikawa.

J. Phys. Chem. Solids, Vol. 10, No. 1, 35-43 (April, 1959).

While $FeTiO_3$ and α-Fe_2O_3 are both antiferromagnetic, some solid solutions of the two possess strong magnetic moments which are believed to be related to an ordering of the Fe and Ti atoms. Neutron powder patterns confirm the X-ray picture of $FeTiO_3$ as alternating layers of Fe and Ti along the [111] axis of the rhombohedral cell with intervening oxygen layers, and provide more accurate oxygen parameters. Data taken below the Neel point of 68°K suggest a model for the spin structure in which Fe^{2+} moments are ferromagnetically coupled within a (111) sheet and directed perpendicular to it. Studies on the solid solutions connect the presence of the spontaneous moment with ordering of the Ti and Fe atoms, and show that the spin arrangement in most of these compositions is of the α-Fe_2O_3 type with spins ferromagnetically coupled and lying within (111) sheets. The fact that no long-range ordered spin structure is observed down to 4.2°K for the sample containing 12% hematite can be explained on the basis of an inhomogeneous magnetic structure.

538.2

7174. ANTIFERROMAGNETIC GROUND STATE.

J.C.Fisher.

J. Phys. Chem. Solids, Vol. 10, No. 1, 44-6 (April, 1959).

The ground-state wave function for an antiferromagnetic spin array, corresponding to the Hamiltonian $H = J\Sigma$ (neighbours) $S_i \cdot S_j$, has been approximated by a simple linear combination of those basis vectors that can be derived from the idealized Neel ground state by transferring a few spin deviations between neighbouring spins. The resulting wave function is very nearly an eigenfunction of H, the corresponding energy is

$$\lambda_0 = -[1 + (2Zs - 1)^{-1}]JZNS^2/2,$$

and the fractional spin alignment is

$$\theta = 1 - ZS/(2Zs - 1)^2.$$

The energy is very close to that given by the spin-wave approximation, but the fractional spin alignment lies about halfway between the spin-wave value and unity.

538.2

7175. PARALLEL SUSCEPTIBILITY OF AN ANTIFERROMAGNETIC CRYSTAL WITH TWO MAGNETIC SUB-LATTICES AT LOW TEMPERATURES.

A.Korchovei.

Rev. de Physique (Bucarest), Vol. 3, No. 1, 57-70 (1958) = Stud. Cercetari Fiz., Vol. 8, 399 (1957). In Russian.

Using the method of spin waves, the author calculates low-temperature susceptibility of an antiferromagnetic for the case when the external magnetic field is parallel to the axis of spontaneous antiferromagnetism (the parallel susceptibility $\chi_{\parallel}$). The result obtained is identical with that reported by Kubo (Abstr. 8309/1952).

A.Tybulewicz

538.27

7176. LINE WIDTHS IN POLYCRYSTALLINE YTTRIUM IRON GARNET.

L.G.Van Uitert, F.W.Swanekamp and S.E.Haszko.

J. appl. Phys., Vol. 30, No. 3, 363-5 (March, 1959).

The line widths at the half-power point for ferromagnetic resonance in a number of polycrystalline yttrium iron garnet samples have been measured at 16 kMc/s. It has been determined that, starting with mixtures of Y_2O_3 and Fe_2O_3, sound parts with small grain size and having line widths as low as 35 to 40 oersteds can be obtained on the iron-rich side of stoichiometry in $Y_3Fe_5O_{12}$. However, narrower line widths (~ 20 oersteds) in large grained materials are obtained by using less than the stoichiometric amount of iron and firing at temperatures higher than 1450°C. This is due to minimizing the disrupting influences of oxygen loss in iron-rich areas at high temperatures. Line widths do not appear to be broadened by the addition of small amounts of nickel, cobalt, or manganese to convert excess iron to high resistance forms of spinel in the iron-rich compositions.

538.27

7177. MICROWAVE RESONANCE IN GADOLINIUM-IRON GARNET CRYSTALS. W.V.Smith, J.Overmeyer and B.A.Calhoun.
I.B.M. J. Res. Developm., Vol. 3, No. 2, 153-62 (April, 1959).

Ferrimagnetic resonance has been observed in single crystals of gadolinium—iron garnet at 9479 and 23 725 Mc/s. The resonance behaviour is discussed in terms of a two-sublattice theory. The gadolinium g-factor is 2.006 above -90°C, and increases at lower temperatures. The gadolinium ions contribute to the anisotropy below -40°C. The assignment of separate damping constants to each sublattice explains the sharp variation in over-all damping with temperature near the compensation point.

538.27

7178. FERRIMAGNETIC RESONANCE MODES IN SPHERES.
P.C.Fletcher and R.O.Bell.
J. appl. Phys., Vol. 30, No. 5, 687-98 (May, 1959).

The magnetostatic solutions of ferrimagnetic resonance in ferrite spheres are briefly derived. General and specific solutions are given for values of n up to five for the magnetostatic potentials, r.f. distributions of magnetization, and fields for resonance. Some experimental results are given and compared with the theory.

538.27

7179. CRYSTAL CONSTITUENT EFFECTS. I. PARAMAGNETIC RESONANCE OF $NiM^{IV}F_6 \cdot 6H_2O$.
R.H.Hoskins, R.C.Pastor and K.R.Trigger.
J. chem. Phys., Vol. 30, No. 2, 601-2 (Feb., 1959).

The X band (9 kMc/s) paramagnetic resonance spectrum of Ni^{2+} in several salts has been investigated in an effort to understand the limiting value of the line width with dilution in dilute $(Zn,Ni)SiF_6 \cdot 6H_2O$. Although the results obtained are inconclusive parameters were evaluated which are not available in the literature.
J.M.Baker

538.27

7180. ELECTRON SPIN RESONANCE SPECTRA FROM GAMMA-IRRADIATED SOLID NITROGEN.
L.A.Wall, D.W.Brown and R.E.Florin.
J. chem. Phys., Vol. 30, No. 2, 602-3 (Feb., 1959).

The electron spin resonance of γ-irradiated solid N_2^{14} and N_2^{15} at 4.2°K is described, and the interpretation of the multiplicity of the observed line is discussed.
J.M.Baker

538.27

7181. ON A NEW METHOD OF THE PARAMAGNETIC RESONANCE MEASUREMENTS. K.Hukuda, K.Horai and Z.Miduno.
Mem. Fac. Sci. Kyusyu Univ., Vol. 2, No. 1, 18-21 (March, 1956).

Some aspects of the distortion of the recorded absorption derivative are discussed for Lorentzian and Gaussian line shapes, when the oscillator is frequency-modulated at high A.F. The technique gives no error in the recorded values of H for maximum absorption. The errors in H for maximum slope of the absorption lines are negligible for small absorptions and decrease with increasing width of the frequency modulation.
A.J.Manuel

538.27

7182. ON THE DETERMINATION OF THE PRINCIPAL g-VALUES IN ELECTRON SPIN RESONANCE. D.S.Schonland.
Proc. Phys. Soc., Vol. 73, Pt 5, 788-92 (May, 1959).

A method of inferring the principal values and the directions of the principal axes of the g-tensor for a paramagnetic complex in a single crystal from measurements of the g-value variation in three different planes is described, and an ambiguity in the determination of the principal values that will often arise in practice is pointed out and discussed. An estimate of the root mean square error in the determination is given.

538.27

7183. ANALYSIS OF THE E.S.R. ABSORPTION SPECTRUM OF WURSTER'S BLUE ION. T.R.Tuttle, Jr.
J. chem. Phys., Vol. 30, No. 1, 331 (Jan., 1959).

A comparison of the electron spin resonance absorption spectrum of Wurster's blue ion with that of its counterpart deuterated in the four ring positions shows unambiguously that the triplet structure on the main lines is associated with the four ring protons. The larger splitting of 7.4 Oe between triplets undoubtedly arises from the interaction of the unpaired electron with the methyl protons. The spectrum of Wurster's blue ion must therefore consist of thirteen quintets whose weakest lines are obscured by approximate coincidence with lines of adjacent quintets. From the data in the literature the spin densities at the methyl and ring protons are calculated to be 0.0148 and 0.0042, respectively. The sign of these densities was not determined.

538.27

7184. BIRADICAL MOLECULAR COMPOUNDS: A STUDY BY ELECTRON SPIN RESONANCE.
D.Bijl, H.Kainer and A.C.Rose-Innes.
J. chem. Phys., Vol. 30, No. 3, 765-70 (March, 1959).

A number of solid paramagnetic molecular compounds (biradical molecular compounds) with different donor—acceptor tendencies was investigated by electron spin resonance. It was found, that (i), the concentration of the paramagnetic compound molecules generally increases with the strength of the donor—acceptor tendency; (ii), this concentration is independent of temperature. The explanation of this situation is a major problem in this field.

538.27

7185. ELECTRON SPIN RESONANCE IN IRRADIATED SINGLE CRYSTAL OF DIMETHYLGLYOXIME. I.Miyagawa and W.Gordy.
J. chem. Phys., Vol. 30, No. 6, 1590-5 (June, 1959).

The paramagnetic resonance of gamma-irradiated single crystals of dimethylglyoxime was measured at 23 and 9 kMc/s for various orientations of the crystals in the magnetic field. The resonance pattern was found to have a triplet structure caused by coupling to a single N^{14} nucleus. Both the nuclear coupling and the spectroscopic splitting factor were found to be anisotropic with the principal values; $A_1 = 45 \pm 1$ gauss, $A_2 = A_3 = 25 \pm 1$ gauss, $g_1 = 2.0026 \pm 0.0003$, $g_2 = 2.0063 \pm 0.0003$, and $g_3 = 2.0095 \pm 0.0003$. It is concluded that the free radical produced by the irradiation is probably the ionized dimethylglyoxime molecule, with the positive charge and the electron spin density concentrated on one of the nitrogens and in an hybridized sp^2 orbital which is approximately in the molecular plane and along the bisector of the $C = N - O$ angle. The s character in the orbital is calculated from the N^{14} coupling to be 19%.

538.27 : 537.311.33

7186. SPIN RESONANCE OF DEEP LEVEL IMPURITIES IN GERMANIUM AND SILICON.
G.W.Ludwig, H.H.Woodbury and R.O.Carlson.
J. Phys. Chem. Solids, Vol. 8, 490-2, 506 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The hyperfine structures of manganese impurities in silicon were observed in relatively slowly quenched and rapidly quenched material. In the former the line structure is attributed to a symmetric tetrahedral grouping of four manganese atoms, and it suggested that these are responsible for the donor level observed 0.53 eV below the conduction band. The rapidly quenched material shows hyperfine structure attributed to single manganese atoms or pairs. Observations on nickel impurity in germanium are interprete in terms of a Jahn—Teller distortion. The hyperfine interaction with Ge^{73} and, in material doped with nickel enriched to 83% Ni^{61}, the hyperfine structure due to interaction with the isotope were detected.
A.J.Manuel

538.27

7187. ELECTRON PARAMAGNETIC RESONANCE IN SINGLE CRYSTALS OF $BaTiO_3$. A.W.Hornig, R.C.Rempel and H.E.Weaver.
J. Phys. Chem. Solids, Vol. 10, No. 1, 1-11 (April, 1959).

The paramagnetic resonance of an impurity in single crystals of BaTiO has been studied. The impurity ion has been identified as Fe^{3+} and is believed to be located at the titanium position in the unit cell. The zero field splittings for the Fe^{3+} ion in the tetragonal ferroelectric phase have been measured at room temperature and as a function of temperature through the Curie point. The values at room temperature are 11.7 and 4.9 kMc/s, respectively. The corresponding zero field splitting in the cubic phase is about 0.90 kMc/s The effects of temperature variation on the resonant magnetic fields are discussed with special reference to the observation of a zero magnetic field transition at 9.5 kMc/s and at a temperature of 75°C.

538.27

7188. ELECTRON SPIN RESONANCE OF ATOMIC AND MOLECULAR FREE RADICALS TRAPPED AT LIQUID HELIUM TEMPERATURE.

C.K.Jen, S.N.Foner, E.L.Cochran and V.A.Bowers.
Phys. Rev., Vol. 112, No. 4, 1169-82 (Nov. 15, 1958).

Electron spin resonance spectra of H, D, N, and CH_3 trapped in solid matrices at liquid helium temperature were observed and interpreted. The effect of the matrix field on the resonance properties of the radicals was investigated by depositing the radicals in matrices with different binding energies. The effect of the matrix on the g factor is extremely small in all cases. The deviation of the hyperfine coupling constant from the free-state value increases in a systematic way with increase in binding energy of the matrix, the percentage deviations being small for H, D, and CH_3 but rather large for the case of N. The widths and shapes of the spectral lines are discussed in terms of dipolar broadening, spin-lattice relaxation, anisotropic broadening, rate of passage and the modulation parameters used for observation. Complex spectra, not adequately identified, were observed from discharges in hydrogen and hydrogen-oxygen systems. Deductive evidence for an HO_2 resonance spectrum is presented. The stable molecular free radicals O_2, NO, and NO_2 were studied. Only NO_2 yielded a positive result. Resonances for oxygen and chlorine atoms have been sought but not observed. It is suggested that radical species with orbital angular momenta may escape spin resonance observation because of matrix field anisotropy and that radical species with an even number of electrons may be unobservable because of crystalline field splitting resulting in a singlet ground level.

538.27 : 539.21

7189. THE POTENTIALITIES AND LIMITATIONS OF THE PARAMAGNETIC RESONANCE METHOD IN RADIATION RESEARCH.

R.Livingston.
Radiation Research, Suppl. No. 1, 463-78 (1959). See Abstr. 5164 (1959).

This paper is not a review but a more or less discursive summary of the author's work in γ-irradiation of dilute acids, of a single crystal of calcium tungstate, of ethyl alcohol and deuterated ethyl alcohol at liquid nitrogen temperatures. Molecular hydrogen yields from irradiated dilute acids agree convincingly with concentrations of atomic hydrogen found by paramagnetic resonance.

J.G.Powles

538.27 : 539.2

COMPLETE THEORY OF Ni(II) AND V(III) IN CUBIC CRYSTALLINE FIELDS. See Abstr. 6260

538.27

7190. ROLE OF DOUBLE-QUANTUM TRANSITIONS IN MASERS.

S.Yatsiv.
Phys. Rev., Vol. 113, No. 6, 1538-44 (March 15, 1959).

A generalized treatment of a three-level maser as an example of double-irradiation experiments is based on a previous analysis of multiple-quantum transitions in nuclear magnetic resonance. The emphasis in the present treatment, as distinct from other expositions of the same problem, is on the role of the double-quantum transitions. In particular, conditions are found in which the maser operation is mainly governed by the double-quantum process and does not require a true "pumping" stage. Such a case is realizable in practice but its technical applicability is questionable. A study of the behaviour of various transitions in this example is instructive for understanding the general role of the double-quantum transitions in double-resonance experiments.

538.27

7191. MULTIPLE-QUANTUM TRANSITIONS IN NUCLEAR MAGNETIC RESONANCE. S.Yatsiv.

Phys. Rev., Vol. 113, No. 6, 1522-37 (March 15, 1959).

The theory of Bloch and Wangsness for nuclear magnetic resonance signals is applied to multiple-quantum transitions. In most of the n.m.r. experiments, the energy level schemes are only slightly different from an equally spaced Zeeman pattern, so that a simultaneous absorption of several radiation quanta with the same frequency can take place. It is found that the multiplicity, or the number of quanta absorbed in the transition, is most easily determined through the specific dependence of the multiple quantum signals on the r.f. field amplitude. The dependence of the signals on various relaxation parameters is developed and is found to provide information about relaxation processes which is not derivable from ordinary single-quantum transitions. A method of enhancing multiple transitions by audio-modulating the radio-frequency field is described. This is helpful in cases where the frequency deviations from an equally spaced Zeeman pattern are so large that a direct multiple transition is too weak to be observed.

538.27 : 532.7

7192. NUCLEAR MAGNETISM IN PURE LIQUIDS. J.G.Powles.

Rep. Progr. Phys., Vol. 22, 433-503 (1958).

This article is concerned with nuclear magnetic resonance effects in pure liquids which result directly or indirectly from the interactions of electrons with nuclei in diamagnetic molecules. Magnetic shielding and indirect spin—spin coupling are discussed in detail both experimentally and theoretically for steady state spectra and for transient measurements. Experimental techniques as such are not treated. The structure and behaviour of liquids is only dealt with in so far as it affects the interactions referred to above. The emphasis is placed on the description and explanation of physical effects rather than any detailed survey of their application to chemical and specifically molecular structure problems. There are some 250 references to literature available in August 1958.

538.27 : 538.561

7193. ON THE THEORY OF NUCLEAR SPIN OSCILLATORS.

S.S.Kurochkin.
Radiotekhnika i Elektronika, Vol. 3, No. 2, 198-201 (1958).
In Russian.

Briefly derives the theory of nuclear spin resonance applied to the frequency control of oscillators used, for example, in the control of the field modulation in proton synchrotrons with alternating gradients.

T.Mulvey

538.27 : 548.735.4

7194. NUCLEAR MAGNETIC RESONANCE IN CRYSTALS.

D.W.McCall and R.W.Hamming.
Acta cryst., Vol. 12, Pt 2, 81-6 (Feb., 1959).

The general problem of crystal structure analysis by means of nuclear magnetic resonance is examined from the point of view of Van Vleck's theory for the second moment of the resonance absorption as applied to single crystals. Assuming only dipolar interactions to be important, and assuming a rigid lattice, a procedure is described for acquiring and analysing the experimental second moments. It is shown that the second moment may be completely described by fifteen parameters in the most general type of crystal and thus only fifteen structural parameters can be uniquely determined from second moment data. The fifteen experimental parameters are related to fifteen sums over internuclear coordinates. The fifteen lattice sums must be equal to the corresponding theoretical lattice sums (from Van Vleck's theory) for the correct crystal structure. Thus a trial-and-error technique may be employed to determine nuclear coordinates. If the structure is known approximately, formulae are presented by means of which one may find the adjustments required in the nuclear coordinates of the trial structure. The calculations are well suited to programming on a high-speed digital computer.

538.27

7195. THE CONSTRUCTION AND WORKING OF A WIDE LINE NUCLEAR MAGNETIC RESONANCE SPECTROMETER AND THE MEASUREMENTS OF SOME CHEMICAL SHIFTS.

S.S.Dharmatti, K.J.Sundara Rao and R.Vijayaraghavan.
Nuovo Cimento, Vol. 11, No. 5, 656-69 (March 1, 1959).

A wide-line nuclear magnetic resonance spectrometer of high sensitivity operating between 4 and 10 Mc/s, is described together with a high stability electromagnet system. Using the spectrometer, the chemical shifts of O^{17} resonance in several compounds have been measured. The results have been interpreted in terms of CO bond character in various groups of organic compounds.

538.27

7196. THE HYDROGEN BOND AND PROTON MAGNETIC RESONANCE. I.V.Aleksandrov and N.D.Sokolov.

Dokl. Akad. Nauk SSSR, Vol. 124, No. 1, 115-18 (Jan. 1, 1959).
In Russian.

Rough numerical estimates are given for contributions to the magnetic shielding constant in the case O—H...O, due to the following effects: O—H bond polarity, variation of O—H bond length, donor—acceptor character in the H^+...O bond, electrostatic reduction of the susceptibility of the O—H bond, and interaction with additional unshared pairs from the second O atom. All but the last give contributions having the experimental order of magnitude, but varying signs. The authors reject the opinion of Schneider, Bernstein and

Pople (Abstr. 2620/1958) that the electrostatic effect alone is sufficient to explain the observed frequency shift. Reasonable values for the parameters in the calculation give a reduction of 15% in the electron density around the proton. I.D.C.Gurney

538.27

7197. EFFECTS OF GADOLINIUM UPON THE H_2O^{17} NUCLEAR RESONANCE. R.G.Shulman and B.J.Wyluda.

J. chem. Phys., Vol. 30, No. 1, 335-6 (Jan., 1959).

Reports O^{17} resonance in O^{17} enriched water (1.2%) and solutions of gadolinium chloride. A diamagnetic shift proportional to Gd^{3+} concentration is found. T_2 and T_1 (by saturation) are measured and in the solutions T_2 is smaller than T_1 by a factor of order 10^3. Possible explanations, particularly of the diamagnetic shift are discussed. J.G.Powles

538.27 : 539.19

7198. EFFECT OF PARAMAGNETIC IONS ON THE NUCLEAR MAGNETIC RESONANCE OF O^{17} IN WATER AND THE RATE OF ELIMINATION OF WATER MOLECULES FROM THE FIRST COORDINATION SPHERE OF CATIONS.

R.E.Connick and R.E.Poulson.

J. chem. Phys., Vol. 30, No. 3, 759-61 (March, 1959).

Observations were made on the relative effectiveness of various paramagnetic ions in broadening the nuclear magnetic resonance of O^{17} in water and it is inferred that the relaxation occurs almost entirely in the first coordination sphere of all the cations studied except chromic ion. Accepting this hypothesis, it is possible to calculate lower limits for the rates of exchange of bulk water molecules with those in the first coordination sphere of the cations. For ferric ion the lifetime of a coordinated water molecule is equal to or less than 10^{-6} second at room temperature.

538.27

7199. NMR STUDY OF FERROCENE, RUTHENOCENE, AND TITANOCENE DICHLORIDE. C.H.Holm and J.A.Ibers.

J. chem. Phys., Vol. 30, No. 4, 885-8 (April, 1959).

The line widths of the proton magnetic resonance absorption spectra and the spin-lattice relaxation times for polycrystalline samples of ferrocene, ruthenocene, and titanocene dichloride were measured as functions of temperature, and are interpreted in terms of reorientation of the cyclopentadienyl rings about their fivefold axes. At low temperatures such reorientation is interpretable in terms of an activated process governed by a single correlation time, and the barrier restricting reorientations is obtained. At higher temperatures for these substances, as well as for benzene, such an interpretation is not suitable, and a hypothesis involving the coupling and uncoupling of adjacent rings taking part in reorientation is proposed to account for the data.

538.27

7200. POTENTIAL ENERGY BARRIER DETERMINATIONS FOR SOME ALKYL NITRITES BY NUCLEAR MAGNETIC RESONANCE.

L.H.Piette and W.A.Anderson.

J. chem. Phys., Vol. 30, No. 4, 899-908 (April, 1959).

A technique for studying rapid chemical exchange and reorientation reactions by nuclear magnetic resonance techniques is discussed. A treatment for the general case relating the changes in the proton line width with changes in the frequency of rotation about the O—N bond in the alkyl nitrites is developed. Such a treatment gives fairly accurate potential energy barriers to rotation for methyl, ethyl, n-propyl, and isopropyl nitrite. A temperature controlling device for low temperatures applicable to proton resonance techniques is discussed.

538.27

7201. NUCLEAR MAGNETIC RESONANCE SPECTRA OF SOME DIALKYLMERCURY COMPOUNDS.

R.E.Dessy, T.J.Flautt, H.H.Jaffé and G.F.Reynolds.

J. chem. Phys., Vol. 30, No. 6, 1422-5 (June, 1959).

The Hg^{199} and H^1 nuclear magnetic resonance spectra of a series of dialkylmercury compounds were obtained. The Hg^{199} results indicate that the shielding of the mercury increases along the series Me < n – Pr < Et < i – Pr. This increased shielding seems to be connected with an interaction of Hg^{199} and the β protons, as evidenced by the H^1 resonance peaks and the Hg^{199}—H^1 spin—spin coupling constants.

538.27

7202. N.M.R. SPECTRUM OF THE ETHYL GROUP. AN EXACT SOLUTION. B.R.McGarvey and G.Slomp, Jr.

J. chem. Phys., Vol. 30, No. 6, 1586-9 (June, 1959).

An exact solution of the spin Hamiltonian for the ethyl group was calculated and the results were compared with the experimental N.M.R. spectra of ethyl sulphide and tetraethylsilane. For ethyl sulphide it was found that $\delta H_0 = 52.8 \pm 0.4$ cycles and 40 Mc/s and $J = 7.42 \pm 0.05$ cycles. For tetraethylsilane, $\delta H_0 = -16.9 \pm 0.4$ cycles at 40 Mc/s and $J = 7.9 \pm 0.2$ cycles.

538.27 : 537.311.33

NUCLEAR MAGNETIC RESONANCE IN SEMICONDUCTORS. See Abstr.6942

538.27

7203. NUCLEAR QUADRUPOLE RESONANCE OF SOME BROMINE AND IODINE COMPOUNDS.

D.S.Alderdice, R.J.C.Brown and T.Iredale.

J. chem. Phys., Vol. 30, No. 1, 344-5 (Jan., 1959).

Br^{79} and I^{127} resonance frequencies are reported for several compounds at -183°C. The numbers of component lines differ in some cases from those previously observed at room temperature by other workers, possibly indicating phase changes. E.F.W.Seymour

MAGNETOHYDRODYNAMICS

ELECTROMAGNETISM

538.3

7204. PENETRATION OF TRANSIENT ELECTROMAGNETIC FIELDS INTO A CONDUCTOR. A.Grumet.

J. appl. Phys., Vol. 30, No. 5, 682-6 (May, 1959).

The case of a uniform electric field, infinite in extent, abruptly applied to the plane face of a semi-infinite conductor is considered. The amplitude of the field as a function of distance into the conductor and of time is then determined for different conductivities. The time element and distance for ignoring the displacement current term in Maxwell's equations is determined. Finally the time and space nature of the applied electric field at distances far removed from the semi-infinite conductor is considered.

538.3

7205. FORMATION OF DISCONTINUITIES IN CLASSICAL NONLINEAR ELECTRODYNAMICS. M.Lutzky and J.S.Toll.

Phys. Rev., Vol. 113, No. 6, 1649-52 (March 15, 1959).

It is shown that discontinuities can develop in the propagation of initially smooth waves governed by a classical nonlinear theory of electrodynamics. The type of theory considered includes as a special case that of Heisenberg and Euler, which describes the modifications that must be made in the Maxwell equations to include the classical limit of the nonlinear vacuum effects of quantum electrodynamics. A particular solution of the equations is constructed by the method of characteristics; this example illustrates how, with the appropriate well-behaved initial conditions, the characteristics can be made to intersect at later times, thus forming discontinuities. The classical approximation fails when the gradient of the field strength becomes large, so that no definite conclusion can be drawn as to the actual physical creation of singularities.

538.3 : 530.145

7206. SOLUTION OF MAXWELL'S EQUATIONS IN TERMS OF A SPINOR NOTATION: THE DIRECT AND INVERSE PROBLEM.

H.E.Moses.

Phys. Rev., Vol. 113, No. 6, 1670-9 (March 15, 1959).

Maxwell's equations for fields with sources in media in which the dielectric constant and permeability are unity are written in terms of a spinor notation which resembles the one used for Dirac's equation for the electron. One can introduce Green's functions and expansions in terms of complete sets of orthogonal functions, analogous to those used in the quantum theory of the electron, to solve Maxwell's equations in more compact form than in terms of the conventional vector notation. In addition, the new notation enables one to solve in a simple way an "inverse radiation problem" which is described as follows. Consider at time $t < 0$ the electromagnetic field to be zero. At time $t = 0$ sources are turned on and then later turned off. The electromagnetic field, which results after this process has been completed, will be a radiation field. One can solve the problem of finding the nature of the sources which will lead to a prescribed final radiation field. It is shown that, in general, the sources are not unique but additional conditions can be given which will make them so.

538.521.2

7207. ON UNIPOLAR INDUCTION. F.Ollendorff.
Arch. Elektrotech. (Berlin), Vol. 44, No. 2, 80-94 (1959). In German.

As a contribution to the classical problem of induction arising from a rotating magnet, a model machine is considered which consists of an iron rotor encased in a fixed coaxial cylindrical container, the cylindrical surfaces of the rotor and container being oppositely magnetized. The problem is idealized to that of two blocks with plane faces separated by a narrow air-gap, the blocks being in a state of uniform relative motion. The electromagnetic field is calculated on the basis of the special theory of relativity.

R.A.Newing

538.3 : 532.5

7208. THE EQUILIBRIUM OF A SELF-GRAVITATING INCOMPRESSIBLE FLUID SPHERE WITH A MAGNETIC FIELD. II.
K.H.Prendergast.
Astrophys. J., Vol. 128, No. 2, 361-74 (Sept., 1958).

For Pt I see Abstr. 8024 (1957). The equilibrium model described in Pt I is shown to be dynamically unstable if the magnetic energy exceeds two-fifths of the gravitational energy.

538.3 : 532.5

7209. THE HYDROMAGNETIC OSCILLATIONS OF AN INCOMPRESSIBLE CYLINDER. R.Simon.
Astrophys. J., Vol. 128, No. 2, 375-83 (Sept., 1958).

Deals with the small oscillations of an incompressible homogeneous cylinder of infinite length under its own gravity and in the presence of a uniform magnetic field parallel to its axis. Moreover, the material is supposed to be an infinitely good conductor, and the displacement currents are neglected. It is shown that the presence of the magnetic field does not alter the equations of motion but only the boundary conditions of the problem. An explicit calculation of the proper frequencies indicates a high stabilizing effect of the magnetic field.

538.3 : 532.5

7210. THE PROPAGATION OF HYDROMAGNETIC WAVES OF FINITE AMPLITUDE IN A HORIZONTALLY STRATIFIED ATMOSPHERE. C.Plumpton.
Astrophys. J., Vol. 129, No. 3, 752-7 (May, 1959).

The vertical propagation of a train of transverse harmonic hydromagnetic waves of finite amplitude in the presence of a uniform vertical magnetic field is discussed. It is shown that, although in this case the motion of the gas cannot be wholly horizontal, the vertical motion is negligible so long as the particle velocity is small compared with the local sonic velocity. Approximate solutions of the field equations are derived, and the results are discussed in relation to the propagation of waves in the solar atmosphere.

538.3 : 532.5

7211. HYDROMAGNETIC SHOCKS. J.Bazer and W.B.Ericson.
Astrophys. J., Vol. 129, No. 3, 758-85 (May, 1959).

All physically admissible solutions of the hydromagnetic shock relations for an ideal polytropic gas are exhibited and classified by purely analytical means. The state ahead of the shock (i.e., on the low-density side) is assumed to be known; no restriction is placed on the direction of the magnetic field in front. It is shown, apart from certain "limit" shocks (e.g., pure gas shocks), that the shock velocity and the quantities characterizing the state behind hydromagnetic shocks may be expressed as simple algebraic functions of the discontinuity in the magnetic field across the shock. A natural classification of all hydromagnetic shocks, based on this representation of the state behind the shock, is given. Several useful analytical properties of the various types of hydromagnetic shocks are derived. The results are illustrated graphically for the case of an ideal monatomic gas. The relation between earlier schemes of classification and the present scheme is discussed.

538.3 : 532.5

7212. NOTE ON THE THEORY OF OSCILLATIONS OF AN INCOMPRESSIBLE FLUID MASS IN THE PRESENCE OF A MAGNETIC FIELD. G.Dricot and P.Ledoux.
Bull. Soc. Roy, Sci. Liege, Vol. 28, No. 5-6, 115-21 (May-June, 1959). In French.

For an incompressible mass oscillating under its own gravity and a superposed magnetic field, it is shown that the correct boundary condition (i.e. the vanishing of the Lagrangian perturbation of pressure at the surface) leads, even if the perturbation of the gravitational field has been neglected in the equation of motion, to a frequency comprising a contribution due to gravity — which is usually the dominating one.

ELECTROMAGNETIC WAVES AND OSCILLATIONS

538.561 : 551.510.535

7213. THE VERY LOW-FREQUENCY EMISSIONS GENERATED IN THE EARTH'S EXOSPHERE. R.M.Gallet.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 211-31 (Feb., 1959).

Naturally occurring, very low-frequency signals not associated with lightning discharges, and strongly correlated with solar activity, were recognized nearly as long as the atmospheric whistlers which have their genesis in lightning discharges. Whereas whistlers have been satisfactorily explained, until recently these other phenomenon have not. From the examination of a large quantity of high resolution spectrograms, it has been deduced that a major fraction, if not all, of these other "noises" are excited in the exosphere by streams and bunches of high-speed ionized particles precipitating into the ionized atmosphere in the presence of the earth's magnetic field. The electromagnetic waves excited are then propagated in the manner of whistlers. The excitation mechanism is similar to the operation of a travelling-wave tube. Two frequencies are simultaneously generated, and are given by:

$$\omega = \left[\frac{\omega_H}{2}\, 1 \pm \left\{1 \pm \left(\frac{\omega_P}{\omega_H}\ \frac{V}{c}\right)^2\right\}^{1/2}\right].$$

Their values depend only on the three parameters: local electronic density in the exosphere, local magnetic field intensity, and particle velocity V. For a large range of conditions, corresponding to middle latitude observations, the low frequency explains many types of noise, and reduces to

$$\omega_1 = \left(\frac{V}{c}\right)^2 \frac{\omega_P^2}{\omega_H}.$$

Most of the observations require particle velocities of the order of 10 000 km/sec. The shape of the spectrum is also very sensitive to the ambient electronic density distribution. A model in which the ratio of electron density to magnetic field strength is almost constant, along a line force in most of the exosphere, seems indicated by several types of noise. Such a model satisfies also the whistler data. The problem of the production of bunches and streams of particles is briefly discussed.

538.561 : 529.786 : 621.317.36*

CONSTRUCTION AND MODE OF OPERATION OF A MICROWAVE FREQUENCY STANDARD. See Abstr. 6476

538.561 : 538.27

OSCILLATOR CONTROL BY NUCLEAR SPIN RESONANCE. See Abstr. 7193

538.566 : 621.372.852.4

7214. POLARIZATION DEPENDENCE AND ANGULAR DISTRIBUTION OF THE REFLECTION COEFFICIENT OF ABSORBERS FOR ELECTROMAGNETIC CENTIMETRE WAVES. K.Walther.
Z. angew. Phys., Vol. 10, No. 6, 285-95 (June, 1958). In German.

Formulae are given for the angular dependence for both polarisation directions, and it is shown that they are verified by measurements. Optimal matching for both polarization directions is effective within approximately 35° for various forms of construction of layer type non-reflecting walls. The layer type of walls is further studied, and experiments are reported which show that the crossed wedge type of non-reflecting wall is effective within 51° when the electric field vector is parallel to the plane of incidence and 66° when it is perpendicular.

H.Motz

538.566 : 535.42

7215. ON THE THEORY OF SCALAR DIFFRACTION AND ITS APPLICATION TO THE PROLATE SPHEROID.
N.D.Kazarinoff and R.K.Ritt.
Ann. Phys. (New York), Vol. 6, No. 3, 277-99 (March, 1959).

Scalar scattering of a plane-wave by a perfectly reflecting body whose surface is a level surface in a coordinate system in which the scalar wave equation is separable is considered. A general method for the computation of the surface distribution is described. This method reduces the problem of finding the surface distribution to that of evaluating a certain contour integral. The distribution induced on a prolate spheroid by an axially-symmetric plane wave is specifically computed. The evaluation by residues of the contour integral, given by the general theory, leads to the expected "creeping wave" interpretation of the residue series in which the attenuation of the "creeping waves" depends, in first approximation, on the local radius of curvature. The asymptotic theory used is applicable for large values of $c\omega$, where 2c is the interfocal distance of the spheroid and ω is the wave number. The surface distribution is computed over the entire shadow region including the tip.

538.566 : 534.21

GUIDED PROPAGATION IN A SLOWLY VARYING MEDIUM. See Abstr. 6629

538.566 : 534.21

PROPAGATION OF ELECTROMAGNETIC WAVES IN SLIGHTLY ROUGH DUCTS. See Abstr. 6626

538.566

7216. ELECTROMAGNETIC FIELDS OF A TRANSIENT MAGNETIC DIPOLE ON THE EARTH'S SURFACE.
B.K.Bhattacharyya.
Geophysics, Vol. 24, No. 1, 89-108 (Feb., 1959).

Transient electric and magnetic fields close to the surface of the earth, as developed by a step-function current flowing in a circular loop of wire, are determined. The effect of the insulating air region is fully taken into account. It is observed that the air region has an appreciable influence on the fields over the surface of the earth. The effect of displacement current within the earth is also considered. Expressions of electric and magnetic fields are utilized to determine (a) the mutual impedance function between the primary loop and a small length of wire and (b) the voltage induced in a secondary loop. Both these functions are found to have appreciable magnitudes only during the time interval between the arrival of the wave travelling through air and that of the wave via the conducting medium. From a study of this duration and the initial amplitude of either of the two functions, it is possible to obtain values of conductivity and permittivity of the earth. Curves are plotted to depict the nature of variation of these functions with time for different values of the electric constants of the earth.

538.566.3

7217. ON THE REFLECTION OF ELECTROMAGNETIC WAVES IN THE IONOSPHERE WITH VERTICAL SOUNDING. P.Szulkin.
Bull. Acad. Polon. Sci. Ser. Sci. tech., Vol. 7, No. 1, 65-8 (1959).

It is shown that significant partial reflections of a radio wave only occur near the distinct layers indicated in vertical ionospheric sounding. The experimental results are thus in agreement with theoretical calculations which take account of the anisotropic nature of the ionosphere. H.J.A.Chivers

538.566.3 : 621.396.821

7218. A NOTE ON WHISTLER PROPAGATION IN REGIONS OF VERY LOW ELECTRON DENSITY. O.K.Garriott.
J. geophys. Res., Vol. 63, No. 4, 862-5 (Dec., 1958).

As wave-frequency approaches the plasma frequency, the refractive index passes through a pole resulting in a maximum group velocity at some frequency below the plasma frequency, and thus suggesting another possible mechanism for the formation of nose whistlers. Digital computations based on an assumed ionospheric model are described, which indicate that although two nose frequencies are possible only one may be observable. G.D.Sims

538.566.3 : 621.396.8

7219. PHASE CHARACTERISTICS OF RADIO-SIGNALS RECEIVED VIA THE IONOSPHERE. D.W.Morris and C.J.Hughes.
Nature (London), Vol. 183, 310-11 (Jan. 31, 1959).

A counter unit has been developed by means of which it is possible to make rapid samplings of the probability distribution of the phase-difference between two signals received by two spaced aerials from a distant transmitter. Results are given for reception of the WWV 20 Mc/s transmission. For wide spacing (26λ) the phase distribution is, in effect, found for the specular component of the ionospheric reflection only; for close spacing (2.2λ) the distribution is less spread owing to the additional spatial phase-correlation in the diffracted component of the reflected signal. G.M.Brown

538.569 : 535.13

7220. INTENSITY AND DAMPING DEPENDENCE OF VARIOUS PARAMETERS DESCRIBING SPECTRAL-LINE SHAPES.
R.D.Waldron.
J. Opt. Soc. Amer., Vol. 49, No. 6, 609-18 (June, 1959).

Analytical expressions are presented for the frequency dependence of loss factor, conductivity, loss tangent, amplitude attenuation per radian (absorption index), imaginary refractive index, amplitude and power attenuation per unit length (absorption coefficient), and reflectivity for a damped harmonic oscillator system. Equations are given for the displacement of maxima of these parameters as a function of line strength and width (intensity and damping). Some limiting value relations are given, and the functional dependences of the parameters illustrated graphically. Applications to physical problems are discussed briefly.

NUCLEAR AND ATOMIC PHYSICS

APPARATUS . PARTICLE DETECTORS

539.1.07 : 539.17

7221. EXPERIMENTAL METHODS FOR THE STUDY OF NEUTRON CAPTURE GAMMA RAYS. G.Bäckström.
Nuclear Instrum., Vol. 4, No. 1, 5-25 (Jan., 1959).

The methods for the determination of energies and intensities of neutron capture gamma rays are reviewed. Special attention is given to the comparison of various types of instruments that have been or may be used in such studies. The problem of establishing decay schemes is discussed, as well as the possibilities of assigning spins and parities to the levels. Methods of determining multipolarities and lifetimes of transitions are also included.

539.1.07 : 537.531

X-RAY INTERFERENCE MEASUREMENTS WITH A PROPORTIONAL COUNTER AND A SINGLE-CHANNEL DISCRIMINATOR. See Abstr. 7039

539.1.07 : 537.56

PRESSURE DEPENDENCE OF THE SATURATION CHARGE OF POLONIUM ALPHA-PARTICLES IN CO_2, AND IN A—CO_2 AND A—CH_4 MIXTURES. See Abstr. 7116

539.1.07

7222. A SCINTILLATION COUNTER WITH NEUTRON AND GAMMA-RAY DISCRIMINATORS. F.D.Brooks.
Nuclear Instrum., Vol. 4, No. 3, 151-63 (April, 1959).

A scintillation counter is described which distinguishes fast neutrons from gamma-rays by means of the different decay times of recoil proton and Compton electron scintillations, respectively. Measurements of the proton—electron resolution for different scintillators are described. It is found, for example, that using a 1 in. thick stilbene crystal, 2 MeV neutrons may be detected with 9.5% efficiency while the detection efficiency for 2 MeV gamma-rays is reduced by decay-time discrimination to less than 0.007%. An application of the counter is described for fission cross-section measurements by fission neutron detection. The decay time properties of the scintillators are discussed and the longer decay time for protons (or alpha-particles) is interpreted in terms of slow (10^{-7}sec) ion recombination processes in the scintillators; these processes produce a slow component in the scintillation decay and in a proton scintillation the proportion of slow component is more than in an electron scintillation.

539.1.07 : 535.376

PLASTIC SCINTILLATORS. See Abstr. 6769

539.1.07

7223. PERFORMANCE OF A LARGE AREA NON FOCUSING ČERENKOV COUNTER AND ABSOLUTE YIELD OF ČERENKOV LIGHT. G.Caglioti, R.Cervellati and L.Mezzetti.
Nuovo Cimento, Vol. 11, No. 6, 850-60 (March 16, 1959).

The design and the performance of a large area, comparatively thin toluene Cherenkov counter are described. The velocity resolution of non-focusing Cherenkov counters and its basic limitation, due to the Landau fluctuations in the emission of fast knock-on electrons, are discussed and compared with those of scintillation counters. The absolute yield of the Cherenkov light is evaluated from the measurements and found to be in good agreement with the theoretical yield.

539.1.07

7224. AN ENERGY SENSITIVE ČERENKOV DETECTOR WITH IMPROVED OPTICAL FOCUSSING. M.Huq and G.W.Hutchinson.
Nuclear Instrum., Vol. 4, No. 1, 30-5 (Jan., 1959).

A Cherenkov detector is described having improved energy selecting properties for protons of energy about 900 MeV. Good focusing from an extended area of a spherical reflecting surface has been realized by minimizing astigmatism in the optical system. The light is produced in a liquid radiator and detected by photomultipliers used in coincidence. The energy resolution is largely determined by the dimensions of the optical stop used. It is about $\pm 4\%$ in the instrument constructed.

539.1.07

7225. DIAMOND CONDUCTION COUNTERS WITH SMALL ELECTRODE SEPARATIONS. F.C.Champion and S.B.Wright.
Proc. Phys. Soc., Vol. 73, Pt 3, 385-92 (March, 1959).

Using good diamond counters and variable electrode separations from 10 μ up to 1 mm, a survey of the surfaces of several specimens allowed the selection of crystals with the most uniform behaviour. The variation of the characteristics of the (pulse height, field) curve with electrode separation, could not be explained for these crystals simply in terms of trapping distribution or field distortion due to dark current. There is evidence that recombination of charge carriers at recombination centres close to the site of ionization is the dominating feature and dislocations are probably the defects responsible.

539.1.07

7226. PROPANE BUBBLE CHAMBER.
A.Loria, P.Mittner, I.Scotoni and G.Zago.
Nuovo Cimento, Vol. 11, No. 5, 718-24 (March 1, 1959). In Italian.

A propane bubble chamber of about 2 litres volume is described: details concerning the membrane expansion mechanism, the structure of the windows and the illuminating system are given. Some features of the use of it, recently made at the CERN synchrocyclotron, are indicated.

539.1.07

7227. 9-INCH LIQUID HYDROGEN BUBBLE CHAMBER IN A PULSED MAGNETIC FIELD.
D.C.Colley, J.B.Kinson and L.Riddiford.
Nuclear Instrum., Vol. 4, No. 1, 26-9 (Jan., 1959).

The construction and operation are described. The hydrogen is expanded in the liquid phase by a stainless steel bellows and the construction is such that it may be used in an intense pulsed magnetic field. The latter is provided by an air-cored solenoid.

539.1.07 : 531.787 : 621.317.39

DEVICE FOR FAST MEASUREMENT OF PRESSURE IN BUBBLE CHAMBERS. See Abstr. 6568

539.1.07

7228. LINING-UP NUCLEAR EMULSION STACKS.
S.Taylor, G.Harris, J.Orear, P. Baumel and J.Lee.
Rev. sci. Instrum., Vol. 30, No. 4, 244-5 (April, 1959).

A method has been devised for introducing reference marks in stacks of nuclear emulsion pellicles by the use of single-strand threads. The reference marks are then used for accurate lining-up of the stack after development. Details of the thread insertion and lining-up processes are described.

539.1.07 : 535.822.1

7229. A MICROSCOPE FOR THE SCANNING OF NUCLEAR RESEARCH EMULSIONS. A.G.Ekspong and B.E.Ronne.
Nuclear Instrum., Vol. 4, No. 3, 129-32 (April, 1959).

The instrument can handle rather large plates. The area which can be reached without moving the plate is 25 × 15 cm. The largest plate which can be examined on the microscope must have one side less than 49 cm. The use of the microscope is facilitated by suitably constructed manual controls. The stage can be moved rapidly and precisely.

539.1.07 : 621.317.725

7230. NEGATIVE FEEDBACK VALVE VOLTMETERS FOR RADIATION PROTECTION MEASUREMENTS WITH THIMBLE CHAMBERS. G.Brunner.
Atomkernenergie, Vol. 3, No. 4, 137-40 (April, 1958). In German.

Discusses the specification of the valve voltmeter for measuring the state of charge of a thimble ionization chamber, and suggests circuit improvements for routine equipment. T.Mulvey

539.1.07 : 621.374.32

7231. A FAST TWENTY-CHANNEL PULSE-HEIGHT ANALYSER.
M.Bonitz and E.J.Berlowitsch.
Nuclear Instrum., Vol. 4, No. 3, 133-9 (April, 1959). In German.

An analyser of the Gatti type, with a resolution better than 1 μsec, is described. Improved discriminators allow the introduction of a new method for increasing the practical number of channels to a multiple of twenty.

539.1.07 : 621.374

7232. STATISTICAL DESIGN BASIS FOR FAST SCALING SYSTEMS. A.W.Pryor and A.G.Klein.
Nuclear Instrum., Vol. 4, No. 1, 1-4 (Jan., 1959).

Considerations of the statistics of random pulses show that design criteria of fast scalers for nuclear particle detection are essentially different from those of equipment intended for operation with regularly spaced pulses. The regularizing action of scalers on random pulses is discussed and conclusions relating to practical systems are given.

539.1.07

7233. A BALLISTIC AMPLIFIER OF LOW NOISE LEVEL FOR IONIZATION CHAMBERS AND COUNTER TUBES. H.Schlumbohm.
Z. angew. Phys., Vol. 10, No. 12, 551-3 (Dec., 1958). In German.

Gives the circuit and other details for an amplifier suitable for use in electron avalanche studies, etc. The effective input noise level is equivalent to 270 ion pairs for a capacitance of 20 pF.
J.D.Craggs

539.1.07

7234. SECTOR TYPE DOUBLE FOCUSING BETA RAY SPECTROMETER. I. GENERAL PROPERTIES.
M.Sakai and H.Ikegami.
J. Phys. Soc. Japan, Vol. 13, No. 10, 1076-9 (Oct., 1958).

The fringing field was found to be easily corrected and not seriously disadvantageous for conventional use. A gathering power of 0.3% was obtained for a resolving power of 0.7%. Since the source can be placed outside of the magnetic field, this type of spectrometer might prove extremely useful for coincidence and correlation measurements.

539.1.07 : 539.165

BETA-RAY SPECTRA OF Cs^{137}. APPLICATION OF SECTOR-TYPE DOUBLE FOCUSING SPECTROMETERS. See Abstr. 7324

539.1.07

7235. THE RESPONSE TO HIGH-ENERGY GAMMA RAYS OF A NaI(Tl) SCINTILLATION SPECTROMETER.
J.Kockum and N.Starfelt.
Nuclear Instrum., Vol. 4, 171-80 (April, 1959).

The pulse-height distributions produced by monoenergetic gamma rays in two NaI(Tl) spectrometers with diameters of 12.7 cm and lengths of 10.2 and 20.4 cm, respectively, were studied. The gamma rays were obtained from a Na^{22} and a Po—Be source (1.28 and 4.43 MeV respectively) and from the following proton induced reactions F^{19}(p,$\alpha\gamma$)O^{16} (6.14 MeV); B^{11}(p,γ)C^{12} (11.7 MeV); Li^{7}(p,γ)Be^{8} (17.6 MeV); and T(p,γ)He^{4} (20.3 MeV). Measurements were performed with cylindric lead collimators of diameters ranging from 2.5 to 17 cm. The variation of the shape of the response function with photon energy is shown to be rather small, thus permitting interpolation and extrapolation towards higher energy. A response function matrix covering the range from 4 to 34 MeV was constructed for the large spectrometer, using the pulse-height distributions obtained in this investigation and the 31 MeV distribution of Koch and Wyckoff (Abstr. 4880/1959). The inverse matrix was computed and used to compare an experimental bremsstrahlung spectrum from a 30 MeV synchrotron with a theoretical one. Good agreement was obtained.

539.1.07

7236. A FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER.
G.Hrehuss, A.Neszmélyi and K.Simonyi.
Periodica polytech., Elect. Engng, Vol. 2, No. 2, 131-40 (1958).

A fast-neutron spectrometer is described, which was developed for the measurement of inelastic neutron spectra in the energy range from 0.8 to 14 MeV. The fast neutron bursts are produced by electronic means deflecting the 200 keV beam of a Cockroft—Walton type accelerator. The neutron detector is a plastic scintillator; the neutron signals are analysed by a fast time analyser of the single-channel type. The duration of neutron bursts is 1-3 mμsec; the time resolution is about 5 mμsec.

539.1.07

7237. THE TECHNIQUES UTILIZED AT THE INSTITUTE OF NUCLEAR PHYSICS OF THE UNIVERSITY OF LIÈGE. IV. A SCREENING SYSTEM FOR THE R.C.L. NUCLEOMETER.
G.Guében and J.Govaerts.
Ann. Soc. Sci. Bruxelles, Vol. 70, No. 3, 256-8 (1956). In French.

Describes the design of a lead screen to reduce background radiation. J.M.Hough

539.1.07

7238. RADIATION DOSIMETRY BY TRANSPARENT PLASTICS.

J.W.Boag, G.W.Dolphin and J.Rotblat.

Radiation Research, Vol. 9, No. 6, 589-610 (Dec., 1958).

Describes in detail an investigation of radiation-induced ultraviolet absorption in methyl methacrylate (Perspex) and polyethylene terephthalate (Melinex). Obtained results suggest a rapid and accurate method of measuring radiation doses between 10^5 and 2×10^8 rads. J.M.Zarzycki

ELEMENTARY PARTICLES

539.12 : 530.145

7239. ON THE ANGULAR DISTRIBUTION OF THE DECAY PRODUCTS OF PARTICLE OF ARBITRARY SPIN.

J.M.Chen, T.H.Ho, D.C.Sen and H.Y.Tzu.

Scientia Sinica, Vol. 8, No. 4, 415-22 (April, 1959).

The angular distribution of the decay products of a particle of arbitrary spin decaying into a particle of spin zero and a particle of spin $\frac{1}{2}$ is investigated. The expressions for the expansion coefficients are derived. It is found that the coefficients of terms of even order spherical harmonics are independent of the detailed form of the interaction Hamiltonian inducing the decay process. But the expansion coefficients of terms of odd order spherical harmonics depend on a parameter α, which is a measure of the interference between the parity conserving amd the parity nonconserving interactions. The maximum values which can be taken by the various coefficients are given. It is found that the maximum values of the even coefficients increase with the value of the spin of the initial particle, while those of the odd coefficients decrease correspondingly. The expression for the density matrix of the initial particle as a function of these expansion coefficients is also given, and can be used to determine the state of polarization of the initial particle and the interference between the parity conserving and parity nonconserving interactions, when the expansion coefficients are known.

539.12

7240. THE ELECTRIC DIPOLE MOMENT OF ELEMENTARY PARTICLES. R.L.Garwin and L.M.Lederman.

Nuovo Cimento, Vol. 11, No. 6, 776-80 (March 16, 1959).

The detection of electric dipole moments of elementary particles is discussed and a new limit to the size of the electron dipole moment is presented ($< \sim e \cdot 1.5 \times 10^{-15}$ cm). This result is used in a discussion of recent observations of positronium annihilation.

539.12

7241. UNSTABLE PARTICLES AS TARGETS IN SCATTERING EXPERIMENTS. G.F.Chew and F.E.Low.

Phys. Rev., Vol. 113, No. 6, 1640-8 (March 15, 1959).

A general method is suggested for analysing the scattering of particle A by particle B, leading to three or more final particles, in order to obtain the cross-section for the interaction of A with a particle which is virtually contained in B. Binding complications are absent if a plausible assumption about the location and residues of poles in the S matrix is accepted. The method is useful for unstable particles from which free targets cannot be made; the special examples of pion and neutron targets are discussed in detail.

539.12 : 530.145

RADIATIVE CORRECTIONS TO BREMSSTRAHLUNG.

See Abstr. 6515

539.12

7242. CIRCULAR POLARIZATION OF GAMMA RAYS FOLLOWING THE EMISSION OF POLARIZED HEAVY PARTICLES.

J.Zimanyi.

Nuclear Phys., Vol. 10, No. 1, 88-91 (Feb. (1), 1959).

The circular polarization of gamma rays following the emission of heavy particles is calculated. It is found that this polarization is proportional to the polarization of the emitted heavy particles. Correlation between the two polarizations can be expressed by known functions of essentially geometrical nature.

539.12

7243. MEASUREMENT OF THE POLARIZATION OF THE EXTERNAL BREMSSTRAHLUNG OF Tl^{204}.

U.Amaldi, Jr, M.Bernardini, P.Brovetto and S.Ferroni.

R.C. Ist. Super. Sanita, Vol. 22, Pt 2, 105-21 (1959). In Italian.

The polarization produced by the electrons emitted near the top of the spectrum (first-order unique forbidden transition) was measured by means of the forward Compton scattering on magnetized iron. The observed effect agrees, within experimental error (about 10%), with the value expected for $-v/c$ polarized electrons.

539.12

7244. INVESTIGATIONS OF BREMSSTRAHLUNG OF ELECTRONS IN THE ENERGY INTERVAL (10^{11}-10^{13}) eV.

J.Benisz, Z.Chyliński and W.Wolter.

Nuovo Cimento, Vol. 11, No. 4, 525-32 (Feb. 16, 1959).

Four high energy ($\sim 10^{12}$ eV) electron—photon cascades were investigated at the first stage of their development. The number and the energy of the electron pairs of the first generation, produced on the first radiation length were estimated and compared with the theoretical values calculated on the basis of the theory of Bethe and Heitler. The same was also calculated according to the theories of Landau, Pomerančuk and Ter-Mikaelyan which take into account the influence of the medium on the bremsstrahlung of electrons of very high energy. The experimental results are in better agreement with the predictions of Landau, Pomerančuk and Ter-Mikaelyan than with those of Bethe and Heitler. This fact confirms the results obtained earlier by the authors.

539.12

7245. THE PRODUCTION AND ABSORPTION OF NEUTRINOS IN BETA-DECAY THEORY. C.P.Enz.

Helv. phys. Acta, Vol. 31, No. 1, 69-88 (1958).

The implications of non-conservation of parity and of lepton charge are studied for the processes (1) $(A, Z-1) \rightarrow (A, Z) + e^- + \nu$; and (2) $p + \nu \rightarrow n + e^+$. The neutrinos from (1) are described by a density matrix which, in a form applicable to pile neutrinos, is used, in particular, to calculate the cross-section $\bar{\sigma}$ for reaction (2). From the general dependence of $\bar{\sigma}$ on the coupling constants the result of Lee and Yang, that $\bar{\sigma}$ is twice as big in the two-component theory as in the conventional theory, is recognized as a special case. In addition, experiments are discussed to determine the spectrum and polarization of pile neutrinos. Attention is also given to Pauli's invariance principle.

539.12

7246. A NOTE ON THE TRIDENT PROCESS. P.K.Aditya.

Nuovo Cimento, Vol. 11, No. 4, 546-52 (Feb. 16, 1959).

The mean free path for direct pair production by high energy electrons has been found for electrons of mean energy 20 GeV and 80 GeV. Electrons were obtained from high energy electromagnetic cascades recorded in nuclear emulsion stacks. Pair energies have been determined by using a modified relation for the pair opening angle. The cascade theory has been used to find the correction for spurious tridents. The trident mean free path values obtained at mean energy 20 GeV and 80 GeV are 10.4 ± 1.2 and 7.7 ± 1.9 respectively, measured in terms of the cascade unit. The results are in agreement with the theoretical predictions.

539.12 : 539.18

7247. THE EFFECTIVE ATOMIC FIELD FOR ELECTRON SCATTERING. E. van der Spuy.

Nuclear Phys., Vol. 10, No. 1, 53-9 (Feb. (1), 1959).

A discussion is given of a correction to the atomic field effective in, for example, electron polarization experiments by double scattering. The correction suggests an explanation of the low azimuthal asymmetry found in such experiments compared with the Mo theory. It is shown to be a many-body problem in which proper recognition of the role of the exclusion principle gives an effective modification of the screened Coulomb field normally used in electro scattering calculations, and in fact at such radii as would have an important effect on the most important phase shifts in such a scattering problem.

539.12 : 530.145

7248. DISPERSION RELATIONS FOR VIRTUAL PHOTOPRODUC ION. A.A.Logunov and L.D.Solovyov.

Nuclear Phys., Vol. 10, No. 1, 60-70 (Feb. (1), 1959).

The matrix element of lowest order (with respect to e) for electron—nucleon scattering involving π-meson production is expressed through a quantity which is called the virtual photoproducti amplitude. Dispersion relations are obtained for this amplitude, it being assumed that at high energies the amplitude is independent of energy. It is shown that as a consequence of this assumption the constants entering the dispersion relations are defined by the gauge invariance condition.

539.12 : 530.145

7249. ON THE THEORY OF DISPERSION RELATIONS FOR VIRTUAL PROCESSES [VIRTUAL PHOTOPRODUCTION].
A.A.Logunov.
Nuclear Phys., Vol. 10, No. 1, 71-81 (Feb. (1), 1959).

539.12

7250. SCATTERING OF POLARIZED ELECTRONS BY POLARIZED NUCLEONS. J.H.Scofield.
Phys. Rev., Vol. 113, No. 6, 1599-1600 (March 15, 1959).

The differential cross-section for the scattering of arbitrarily polarized charged spin one-half particles by arbitrarily polarized charged spin one-half particles with an anomalous magnetic moment is calculated, including recoil effects.

539.12

7251. DETERMINATION OF THE AVERAGE ENERGY CONSUMPTION W_L FOR β PARTICLES IN AIR. G.Brunner.
Naturwissenschaften, Vol. 46, No. 1, 9 (1959). In German.

Results of measurements carried out with an extrapolation chamber and a liquid β-emitter electrode (pure β emitters P^{32}, Y^{90}, Tl^{204}, and $\beta-\gamma$-emitters Na^{24}, Co^{60}, Br^{82} in aqueous solutions), using a novel compensation method [Brunner, Abstr. 159B/1959; Z. angew. Phys., Vol. 10, 98 (1958)] yielded, as a weighted mean, the value $W_L = 33.9 \pm 0.5$ eV. F.Lachman

539.12

7252. EFFECT OF IMPURITIES ON ANGULAR CORRELATION OF POSITRON ANNIHILATION RADIATION. R.L.deZafra.
Phys. Rev., Vol. 113, No. 6, 1547-55 (March 15, 1959).

Angular distribution measurements on two-quantum annihilation radiation from positrons stopping in liquid targets were made as a function of concentration of certain impurities in the target materials. The impurities tested were Mn^{++} and Co^{++} ions (dissolved from their chloride salts) and NO_2^- and NO_3^- ions (dissolved from their sodium salts) in water, and chloroform and the free radical diphenyl-picryl-hydrazyl in benzene. The paramagnetic ions were found to produce a strong enhancement of the narrow-distribution component, ascribed to exchange conversion between triplet and singlet positronium. Conversion cross-sections of a few times 10^{-19} cm^2 are obtained assuming a positronium velocity about 5 times thermal velocity at conversion. These are in fair agreement with recent determinations made from lifetime studies. The nitrate and nitrite ions may cause a further broadening of the broad component, which appears to be associated with the chemical binding of positrons to the ions. It is also found that positrons are chemically bound to the chloroform molecule. Some evidence is presented to show that the free radical (diphenyl-picryl-hydrazyl) may not, as previously supposed, act to convert triplet to singlet positronium, but may in fact give rise to chemical binding of positronium to the free radical.

539.12

7253. A NEW METHOD FOR THE MEASUREMENT OF RELATIVE MULTIPLE SCATTERING ON HIGH ENERGY ELECTRON PAIRS. R.Weill.
Nuovo Cimento, Vol. 11, No. 6, 781-7 (March 16, 1959).

The limitation of the "dipole effect" (electron—positron screening) as a method for determining the energy of electron pairs in nuclear emulsion is discussed. It is then shown that the multiple scattering, which is mainly responsible for the separation of the trajectories at a great distance from the origin (~ 1 mm) can be evaluated from the measurement of the "geometrical effect". This phenomenon is studied experimentally on electron pairs of energy between 0.6 and 1 GeV, for trajectory separations up to 0.6μ.

539.12

7254. DIRECT PRODUCTION OF ELECTRON PAIRS BY HIGH-ENERGY ELECTRONS. R.Weill.
Helv. phys. Acta, Vol. 31, No. 7, 641-60 (1958). In French.

The methods of energy measurement of electron pairs discussed previously were improved: the limits of application of direct angle measurements were recalculated; and the three dimensional model of track formation, which accounts for the variation of ionisation on the initial track of electron pairs, was perfected. These results, joined to previous study of spurious scattering (Abstr. 5184/1958) confirm the energy measurements made for the determination of the mean free path λ of direct electron pairs production. It has been found that the values of the Kaplon and Koshiba's factor f_i used for the calculation of the number of pseudotridents are too large. This can introduce an overestimation on λ up to four times at 100 GeV. If the disagreement between Bhabha and Racah's theoretical values and the experimental determination of λ seem to be established, the values deduced from Stueckelberg's remark agree quite well with the experiment. The influence was calculated also of "anomalous" trident production on shower development.

539.12

7255. FORMATION OF POSITRONIUM IN AN ELECTRON GAS.
M.A.B.Bég and P.M.Stehle.
Phys. Rev., Vol. 113, No. 6, 1545-7 (March 15, 1959).

It is shown that for a positron in a free electron gas, radiationless capture, to form positronium, is very likely prior to annihilation.

539.12

7256. HIGH ENERGY NUCLEON—DEUTERON ELASTIC SCATTERING AND THE NUCLEON—NUCLEON FORCES.
J.Sawicki and S.Watanabe.
Nuclear Phys., Vol. 10, No. 2, 151-9 (Feb. (2), 1959).

The differential cross-sections and the polarization are calculated for the 100 MeV and 40 MeV nucleons elastically scattered from deuterons. A kind of impulse approximation is used with the elementary scattering operators corresponding to the phase shifts resulting from Gammel—Thaler and Marshak—Signell potentials. The results for both cases are compared with the existing experimental data.

539.12

7257. TOTAL CROSS SECTION FOR n—p SCATTERING AT 20 MeV. R.B.Day, R.L.Mills, J.E.Perry, Jr and F.Scherb.
Phys. Rev., Vol. 114, No. 1, 209-14 (April 1, 1959).

The total scattering cross-section for neutrons incident on protons has been measured in a good-geometry transmission experiment. The scatterer was hydrogen gas contained in a pressure vessel vessel 1 m long, at a pressure of 4000 p.s.i. The resulting cross-section is $\sigma_t = 0.494_2 \pm 0.0025$ barn at a laboratory neutron energy of 10.665 ± 0.026 MeV.

539.12 : 539.17

POLARIZATION OF NUCLEONS IN INELASTIC SCATTERING FROM NUCLEI. See Abstr. 6105

539.12

7258. CUT-OFF MODELS OF THE PROTON. R.Hofstadter.
Nuovo Cimento, Vol. 12, No. 1, 63-9 (April 1, 1959).

It is demonstrated that the form factor fitting the electron—proton scattering data, which could formerly be described by an exponential density distribution, can also be given entirely equivalently by one of several cut-off proton models. Such models have a theoretically desirable asymptotic behaviour, according to present ideas of field theory.

539.12

7259. ON THE ELASTIC p—d SCATTERING AT HIGH ENERGIES.
L.Favella and M.Olivetti.
Nuovo Cimento, Vol. 11, No. 5, 679-92 (March 1, 1959).

The validity is investigated of the impulse approximation in the elastic p—d scattering for protons of 310 MeV. The numerical results for the differential cross-sections and polarizations as functions of the angle of scattering show clearly that this approximation is inadequate for the prediction of the additivity of these observables as it has been proved experimentally. The reason of the failure is due to the large nuclear two-body interaction in the triplet states.

539.12

7260. PHASE-SHIFT ANALYSIS OF PROTON—PROTON SCATTERING EXPERIMENTS BELOW 40 MeV. M.H.MacGregor.
Phys. Rev., Vol. 113, No. 6, 1559-74 (March 15, 1959).

A phase-shift analysis was made of p—p angular distribution measurements at 1.855, 4.203, 9.68, 9.73, 18.2, 19.8, 31.8, and 39.4 MeV. At 1.855 MeV, Coulomb effects plus the nuclear S-wave phase shift are sufficient to give agreement within experimental errors. At 10 MeV, S-, P-, and D-wave effects are apparent. At 40 MeV, F-wave components are also necessary. With the aid of the Clementel-Villi parametrization method, it has been possible to determine all of the least-squares fits to the angular distribution data in the S, P, D approximation. Polarization measurements and potential model calculations can be used to further restrict the allowable phase-shift sets. It is shown that angular distribution measurements with an accuracy of 0.1% would not lead to a unique set of phase shifts. Both double- and triple-scattering experiments are necessary in order to remove the ambiguity.

539.12 : 539.18

CALCULATIONS ON THE PRODUCTION OF INTENSE BEAMS OF POLARIZED PROTONS. See Abstr. 6170

539.12

7261. EFFECTIVE MEAN FREE PATH OF ANTINUCLEONS IN NUCLEAR MATTER. J.R.Fulco.

Phys. Rev., Vol. 114, No. 1, 374-6 (April 1, 1959).

The effective mean free path for antinucleons in nuclear matter is calculated at intermediate energies from the Fermi gas model, in terms of the nucleon—antinucleon total and differential scattering cross-sections. The results are used to obtain the imaginary part of the optical-model potential in the formalism of Riesenfeld and Watson.

539.12

7262. ANTIPROTON—NUCLEON ANNIHILATION PROCESS. II. O.Chamberlain, G.Goldhaber, L.Jauneau, T.Kalogeropoulos, E.Segrè and R.Silberberg.

Phys. Rev., Vol. 113, No. 6, 615-34 (March 15, 1959).

For previous part, see Abstr. 3225 (1957). Most of the data come from an exposure at the bevatron to an enriched antiproton beam of 700 MeV/c momentum. The analysis is presented of 221 antiproton stars, 95 of which occurred in flight. An average antiproton cross-section of $(1.9 \pm 0.2)\sigma_0$ was found, where $\sigma_0 = \pi(1.2 \times 10^{-13}A^{1/3})^2$ cm^2, for all the elements in emulsion, excluding hydrogen. The primary antiproton annihilation gives rise to 5.36 ± 0.3 pions on the average. In annihilations at rest, 1.3 of the pions formed interact with the parent nucleus; in reactions in flight, 1.9 of the pions. For stars at rest the energy available in the annihilation in complex nuclei is divided up among the products as follows: charged pions, 48 ± 6%, neutral particles (other than neutrons and K^0 mesons) 28 ± 7%; K mesons 3 ± 1.5%; and cascade nucleons and nuclear excitation 21 ± 2%. For the stars in flight the corresponding percentages are: 45 ± 7%, 22 ± 7%, 3 ± 1.5%, and 30 ± 2%. To fit the average pion multiplicity, the interaction radius of the Fermi statistical model must be taken as $2.5\hbar/m_\pi c$. Other proposals to explain the large multiplicity are discussed. From the fraction of pions interacting in the same nucleus one deduces that the annihilation takes place at the outer fringes of the nucleus.

539.12

7263. CLOUD-CHAMBER MEASUREMENT OF THE HALF-LIFE OF THE NEUTRON. N.D'Angelo.

Phys. Rev., Vol. 114, No. 1, 285-91 (April 1, 1959).

The half-life of the free neutron has been measured and found to be 12.7 min with an error of ~ 15%, ~ 10% being due to the poor statistics. This determination has about the same accuracy as the best previous measurement and confirms it by an independent method.

539.12 : 539.21

SCATTERING OF LONG WAVELENGTH NEUTRONS BY IRRADIATED AND UNIRRADIATED QUARTZ. See Abstr. 6291

539.12

7264. NEUTRON TRANSMISSION PROBABILITY THROUGH A CURVED REVOLVING SLIT. M.Marseguerra and G.Pauli.

Nuclear Instrum., Vol. 4, No. 3, 140-50 (April, 1959).

The formulae of a neutron burst transmitted by a revolving curved slit are analytically derived and are then applied to determine the distribution of the neutrons of the burst, after they have travelled a given distance.

539.12

7265. DETERMINATION OF THE NEUTRON EMISSION OF A NEUTRON SOURCE. P.Wunderer.

Z. angew. Phys., Vol. 10, No. 12, 537-46 (Dec., 1958). In German.

The strengths of two thermal neutron sources, Ra—Be and Po—Be, were measured using Mn^{55} as a neutron indicator. The sources were placed at the centre of a large aluminium sphere filled with a solution of $MnSO_4$; a fraction of the Mn^{55} was precipitated and its γ-activity measured by twelve methane counters. Most of the neutrons were absorbed by the manganese and hydrogen, but corrections were made for absorption by the sulphur, oxygen and source. The γ-counters were calibrated against $MnSO_4$ solution of known activity. The ratio of the H and Mn cross-sections was found, using gold foils as indicators to measure the neutron flux in water and in an $MnSO_4$ solution. D.H.Lord

539.12

7266. TO INTRODUCE THE IMPACT PARAMETER INTO THE ANALYSIS OF MULTIPLE MESON PROCESSES. H.Ezawa.

Nuovo Cimento, Vol. 11, No. 6, 745-59 (March 16, 1959).

Showing the inadequacy of Fermi's theory with impact parameter, the author proposes another way to infer the impact parameter for each event in the emulsion from the experimentally observable quantities. The impact parameters introduced in this way have admissible order of magnitude and are shown to have a somewhat definite functional relation with the multiplicity of mesons whose plot versus primary energy has been known to suffer large fluctuation. Consistency with the uncertainty principle is also discussed.

539.12

7267. DECAY OF HYPERONS AND MESONS FROM THE UNIVERSAL FERMI INTERACTION. A.Fujii and M.Kawaguchi.

Phys. Rev., Vol. 113, No. 4, 1156-61 (Feb. 15, 1959).

The decay of the hyperon, charged pion, and K meson except $K_{\pi3}^+$ is investigated on the basis of the universal V—A Fermi interaction together with the idea of the Gell-Mann tetrahedron, by treating the virtual baryon—antibaryon pair effect in a phenomenological way. It is shown that the decay rate of $K_{\pi2}^+$ calculated by the parameters adjusted to the decay of π^+, $K_{\mu3}^+$, and K_{e3}^+ is in agreement with experiment, thus suggesting a possible consistent picture of the model.

539.12

7268. MESON MASS SPECTRUM. K.M.Guggenheimer.

Nuovo Cimento, Vol. 11, No. 2, 287-8 (Jan. 16, 1959).

539.12

7269. ON THE MASS OF ELEMENTARY PARTICLES. A.Carrelli.

Nuovo Cimento, Vol. 11, No. 2, 289-90 (Jan. 16, 1959).

It is noted that the formula suggested by Fröhlich for the masses of π and K mesons and hyperons does not work for the antiparticles. Masses are expressed as an integral multiple of 137 M_e, where M_e is the mass of the electron. Contributions to the masses from strong interactions are presumed to be negligible. A modification to Fröhlich's formula is suggested which gives the same mass values, works for antiparticles, and allows the possibility of a spectrum of particles. A.Ashmore

539.12

7270. MESON PRODUCTION IN NUCLEON—NUCLEON COLLISIONS.

A.Ramakrishnan, N.R.Ranganathan and S.K.Srinivasan.

Nuclear Phys., Vol. 10, No. 2, 160-5 (Feb. (2), 1959).

A calculation of the amplitude for meson production is presented, using the method of Low (Abstr. 3453/1955). By making a suitable Tamm—Dancoff approximation, the matrix element for the process is expressed in terms of the two-nucleon potential, pion—nucleon scattering matrix element and nucleon vertex operator.

539.12

7271. POSITRON SPECTRUM FROM THE DECAY OF THE μ MESON. W.F.Dudziak, R.Sagane and J.Vedder.

Phys. Rev., Vol. 114, No. 1, 336-58 (April 1, 1959).

A magnetic spiral-orbit spectrometer was used to study the positron spectrum from an isotropic μ^+ decay. The detected positrons were identified by an electronic technique designed to measure the lifetime of the muon. The authors' measured weighted mean value of the μ^+ mean life is $\tau_\mu = 2.21 \pm 0.02$ μsec. The data were analysed according to the simplified one-parameter theory of Michel (see Abstr. 5516/1950) as modified by Behrends, Finkelstein, and Sirlin (see Abstr. 908/1956), and corrected by Berman to include radiative corrections to the muon decay theory. The authors obtained $\rho_M = 0.741 \pm 0.027$ for the Michel parameter as the weighted mean value from four experiments. In these experiments the measurements in the low-energy positron region were not of sufficient accuracy to yield an estimate of the second Michel parameter. Included is a measurement of the maximum positron energy. The weighted mean value of this measurement is $W = 52.87 \pm 0.07$ MeV. From this value and its simple algebraic relation to the masses of the decay particles one obtains a value of the μ^+ mass $\mu = 206.94 \pm 0.27$. Tables of the radiative correction to muon decay are given as well as the total corrections that must be added to the Michel parameter that is derived from experimental data by using the simple Michel theory without radiative corrections. For the energy region of the majority of experiments from which the ρ_M value is determined, this total correction in $\Delta\rho$ is approximately 0.040. From the authors' measured value of the maximum positron energy, an estimate is mad of the possible upper limit on the mass of the neutral particle in muon decay. This upper limit is reported as 8 electron-mass units.

539.12

7272. LIFETIME DETERMINATION FOR MUONS FROM ANOMALOUS ABSORPTION, USING NUCLEAR EMULSION METHOD. M.Suk.

Czech. J. Phys., Vol. 7, No. 1, 26-33 (1957). In Russian.

The use of nuclear emulsion as a detector automatically restric the measurements to muons whose energy is so low that energy losses due to polarization are not significant. For the same reason pion production in the absorber may also be neglected. When these two effects are eliminated it is found that the muon lifetime τ_0 determined by anomalous absorption is independent of the Z of the absorber, within the limits of experimental error. Thus the experimentally determined values of τ_0 in lead and graphite are respectively: 2.4 ± 0.3 and 2.25 ± 0.32 μsec. J.W.Gardner

539.12

7273. THE RADIATIVE CAPTURE OF μ^--MESON BY PROTON. Y.B.Dye, D.C.Sen, T.H.Ho and H.Y.Tzu.
Scientia Sinica, Vol. 8, No. 4, 423-8 (April, 1959).

The radiative capture of μ^--meson by proton is treated by using the renormalized universal Fermi interaction of the V—A type and Zel'dovich's theory on μ-mesic hydrogen. Contrary to the result of Lee, Huang and Yang, it is found that if the effect of the strong interaction is neglected, then it is impossible for a photon to be emitted during the capture. The influence of the strong interaction consists in two respects: the effect of the magnetic moment of the nucleon and the renormalization effect on the universal Fermi weak interaction. The effect of the anomalous magnetic moment is negligible. However, the contribution of proton to the emission of the photon is not at all small in comparison with that of the μ-meson, due to the renormalization effect on the universal Fermi weak interaction. As a result, the photons emitted are no longer 100% right-hand polarized. It is estimated that only 82% of the photons has a spin parallel to its momentum. The radiative capture rate of the μ^--meson by proton is $(1.6 \times 10^5)^{-1}$ of the total capture rate.

539.12

7274. NOTE ON LEPTONIC DECAY OF PION. P.Prakash.
An. Acad. Brasil. Cienc., Vol. 30, No. 4, 451-3 (1958).

Theoretical remarks on the $\pi \rightarrow e + \nu$, $\pi \rightarrow \mu + \nu$ branching ratio. J.C.Taylor

539.12 : 530.145

7275. π—e DECAY AND THE UNIVERSAL INTERACTION. C.G.Oliveira and J.Tiomno.
An. Acad. Brasil. Cienc., Vol. 30, No. 4, 455-63 (1958).

This gives a form of universal Fermi interaction which, in conjunction with global symmetry, reduces the rate of $\pi \rightarrow e + \nu$ relative to $\pi \rightarrow \mu + \nu$. J.C.Taylor

539.12

7276. DIRECT DECAY $\pi^0 \rightarrow e^+ + e^-$. S.D.Drell.
Nuovo Cimento, Vol. 11, No. 5, 693-7 (March 1, 1959).

The decay is discussed and analysed as a probe of "pion size".

539.12

7277. ON THE RADIATIVE DECAY OF CHARGED π-MESONS. N.Cabibbo.
Nuovo Cimento, Vol. 11, No. 6, 837-42 (March 16, 1959).

The radiative decay $\pi^+ \rightarrow \mu^+ + \nu + \gamma$ is examined in the frame of the A—V theory of weak interactions. The modifications of the spectrum of μ^+ emitted due to the structure of the μ-meson are in part related to the process $\pi^0 \rightarrow \gamma + \gamma$. These modifications turn out to be negligible.

539.12 : 530.145

7278. RADIATIVE CORRECTIONS TO FERMI INTERACTIONS. T.Kinoshita and A.Sirlin.
Phys. Rev., Vol. 113, No. 6, 1652-60 (March 15, 1959).

The radiative correction to the decay spectrum of polarized muons is recalculated taking into account a mistake in the authors' previous work which was recently pointed out by Berman Abstr. 4922/1959). The revised values for the radiative correction o δ, ξ, and integrated asymmetries for the high- as well as low-energy decay electrons have turned out to be practically identical with the old values. The ρ value determined from experiments, on he other hand, has to be increased by about 1% because of the new orrection. Thus the over-all effect of the radiative correction to he ρ value is now an increase of the order of 5.6% when the experimental and theoretical spectral distributions are compared in the region $0 \leq p/p_{max} \leq 0.95$. The radiative corrections to the spectrum and lifetime of the nuclear β decay arising from the charge interactions of the electron and proton are also studied. Use of this expression gives a correction of −1.7% for the lifetime of O^{14}. The orrected Feynman—Gell-Mann coupling constant is $G = (1.40 \pm 0.01) \times 10^{-49}$ erg/cm³. In the universal V—A theory of weak interactions, he calculated muon mean life becomes $\tau_\mu = (2.31 \pm 0.05) \times 10^{-6}$ sec. (These three values depend logarithmically on the ultraviolet cutoff λ and the corrections to τ_μ increase for increasing values of λ.) It is found that the corrections to the spectral shape of β decay are rather large in the case in which the end-point energy $E_m \gg m_e c^2$. The radiative corrections to the lifetime and the total asymmetry for muon decay are found to be well defined and finite for $m_e \rightarrow 0$ in spite of the fact that the differential spectrum itself diverges logarithmically in the same limit. The same situation is encountered in the case of radiative corrections to the nuclear β decay. A physical explanation for such behaviour of the radiative corrections is attempted. A simplified expression is given for the determination of the Michel parameter.

539.12

7279. INTERACTION OF 4.2 GeV π^--MESONS WITH NUCLEAR EMULSION. P.Abrahamson, J.Ben-Arieh, G.Yekutieli and G.Alexander.
Nuovo Cimento, Vol. 12, No. 1, 27-37 (April 1, 1959).

1425 interactions of 4.2 GeV π^--mesons with emulsion nuclei, found by area scanning were studied. A total mean free path of (32.4 ± 4) cm was obtained. The mean multiplicity per star was found to be 1.72 for charged pions and 2.48 for fast protons. These figures were compared with the statistical model of Fermi. The angular distributions and energy spectra of the secondary particles were obtained and compared with the corresponding results for 5 GeV π^--p interactions.

539.12

7280. A THEORETICAL APPROACH TO LOW ENERGY PION PHYSICS. B.Bosco, S.Fubini and A.Stanghellini.
Nuclear Phys., Vol. 10, No. 6, 663-87 (May (1), 1959).

A new approach is proposed for the study of problems involving low-energy pions. The method starts from a determination of the pion—nucleon scattering state vector in terms of the physical nucleon state vector and of the renormalized coupling constant. Such a determination can be performed in the one-meson approximation and leads in a simple and natural way to the same results as the Chew and Low (Abstr. 2680-1/1956) approach to scattering and photoproduction. The method is then applied to the problem of radiative pion—nucleon scattering, where an expression is obtained for the T matrix in a closed form which has the same degree of validity as the result for photoproduction. Although the method has its natural field of application in the framework of the static model, it can be applied to obtain the recoil effects due to the motion of the physical nucleon. In the case of pion—nucleon scattering, results are obtained closely analogous to those obtained in the framework of relativistic dispersion theory.

539.12

7281. THE ISOBARIC SELECTION RULE FOR HYPERONS AND K-MESONS. K.Nakagawa.
Nuclear Phys., Vol. 10, No. 1, 20-7 (Feb. (1), 1959).

The weak decay processes for hyperons and K-mesons are analysed to test the isobaric selection rule $|\Delta I| = \frac{1}{2}$. It is shown that only one possible type is left for the Σ-decay interaction when the rule $|\Delta I| = \frac{1}{2}$, the T-invariance and the one-to-one law are assumed.

539.12

7282. EVIDENCE FOR THE TRANSITION OF A K^0 INTO A $\bar{K}^0$ MESON. F.S.Crawford, Jr, M.Cresti, M.L.Good, K.Gottstein, E.M.Lyman, F.T.Solmitz, M.L.Stevenson and H.Ticho.
Phys. Rev., Vol. 113, No. 6, 1601-4 (March 15, 1959).

Two pictures were obtained in a liquid-hydrogen bubble chamber, each of which demonstrates the following sequence:

$$(1)\ \pi^- + p \rightarrow Y^0 + K^0,\ [Y_A{}^0 = \Lambda^0,\ Y_B{}^0 = \Sigma^0]$$
$$(2)\ \Lambda \rightarrow p + \pi^-,$$
$$(3)\ K^0 \rightarrow (\sim 50\%)K^0 + (\sim 50\%)\bar{K}^0,$$
$$(4)\ \bar{K}^0 + p \rightarrow \Sigma^+ + \pi^0,$$
$$(5)\ \Sigma^+ \rightarrow n + \pi^+,$$

where step (3) is not directly observable, but is a prediction of the theory of Gell-Mann and Pais. On the basis of two events, the cross-section for process (4) is 30 mb.

539.12

7283. LIFETIMES AND DECAY SPECTRA OF τ'^+ AND $K_{\mu_3}{}^+$. S.Taylor, G.Harris, J.Orear, J.Lee and P.Baumel.
Phys. Rev., Vol. 114, No. 1, 359-64 (April 1, 1959).

Nuclear emulsion stacks were exposed to the bevatron ~360-MeV/c unseparated K+ beam at two different distances from the target. The K_L to τ' and K_L to K_{μ_3} ratios at the two positions, combined with the known K_L lifetime, yield $(1.0_{-0.3}^{+0.5}) \times 10^{-8}$ sec for the τ' mean life and $(1.2_{-0.4}^{+1.0}) \times 10^{-8}$ sec for the $K_{\mu 3}$ mean life. These lifetimes, when compared with other K^+ lifetimes, are consistent with a single lifetime for all K^+ mesons. The π^+ energy spectrum from τ'^+ decay is obtained, using 72 events, and by Dalitz-type analysis is found to be consistent with spin zero but would be unlikely for spin one. Hence, the τ' spin is consistent with being the same as that of the τ. The μ^+ energy spectrum from $K_{\mu 3}{}^+$ decay is obtained from 0 to 63 MeV, using 47 events, and is found to be consistent with the energy distribution of the density of final states in the region. The relative abundances of τ^+, τ'^+, and $K_{\mu 3}{}^+$ are found to be 0.052 ± 0.003, 0.015 ± 0.002, and 0.028 ± 0.004, respectively, the $K_{\mu 3}$ abundance having been estimated by assuming that the μ^+ spectrum above 63 MeV is proportional to the density of final states.

539.12

7284. ON K⁻—HYDROGEN INTERACTIONS.

W.Alles, N.N.Biswas, M.Ceccarelli, R.Gessaroli, G.Quareni, M.Göing, K.Gottstein, W.Püschel, J.Tietge, G.T.Zorn, J.Crussard, J.Hennessy, G.Dascola and S.Mora.
Nuovo Cimento, Vol. 11, No. 6, 771-5 (March 16, 1959).

Experimental data are given on the interaction of K^--mesons with hydrogen nuclei. These emulsion data agree with new bubble chamber data. They indicate an essentially isotropic angular distribution, both for scattering and for absorption events, a slight decrease of the elastic scattering cross-section with energy and a larger one of the absorption cross-section.

539.12

7285. NUCLEAR INTERACTIONS OF NEUTRAL K-MESONS OF LONG LIFETIME. II.

V.Bisi, R.Cester, A.Debenedetti, C.M.Garelli, N.Margem, B.Quassiati and M.Vigone.
Nuovo Cimento, Vol. 12, No. 1, 16-26 (April 1, 1959).

For Pt I, see Abstr. 2646 (1959). The increased statistics allows the results previously obtained to be checked and the cross-section determined for charge exchange of the θ_2^0 particles in the eigenstate of strangeness −1.

539.12

7286. UNPHYSICAL REGION IN HEAVY-MESON—NUCLEON DISPERSION RELATIONS.

S.F.Tuan.
Phys. Rev., Vol. 113, No. 5, 1375-8 (March 1, 1959).

The contribution to K-meson—nucleon dispersion relations from the unphysical region due to absorption is examined in perturbation theory; it is found that the contribution need not be negligible for scalar K-mesons or the case where Λ has opposite relative parity from (K,Σ). The influence this has on a dispersion-theoretic analysis of K-meson scattering is noted. In the Appendix the mass relationships for a rigorous derivation of the dispersion relations are discussed.

539.12

7287. HEAVY-MESON—HYPERON RELATIVE PARITY AND THE SIGN OF THE COULOMB INTERFERENCE IN K⁻—p SCATTERING.

E.Galzenati and B.Vitale.
Phys. Rev., Vol. 113, No. 6, 1635-40 (March 15, 1959).

Two subtracted dispersion relations are applied at the same time to the study of the dependence of the real part of the K^-—p scattering amplitude at zero energy, $D_-(K)$, on the values of the coupling constants $g_Y{}^2$. The results, when compared with the existing experimental information, strongly indicate that the K meson is ps—ps (namely pseudoscalar with respect to both the Λ and the Σ hyperon) and that the sign of $D_-(\omega)$ at low energy is positive, giving therefore constructive Coulomb interference in the K^-—p elastic scattering.

539.12

7288. INDICATION FOR K, Λ,Σ RELATIVE PARITIES FROM EFFECTIVE-RANGE ANALYSIS OF K⁺p SCATTERING.

D.Amati.
Phys. Rev., Vol. 113, No. 6, 1692-5 (March 15, 1959).

From dispersion relations, an effective range formula is derived for K^+—p scattering. In the expression for the effective range, the integrals over the cross-sections are certainly convergent and weighted against the contributions from the unphysical region. This expression is then analysed under the experimentally suggested hypothesis of rather constant K^+—p cross-sections up to ~ 110 MeV, it is observed that the effective range is rather energy independent and the integrals contributing to it are estimated to be all of the same sign. The expression for the effective range is then quantitatively evaluated, and it is shown that the comparison with the low-energy dependence of σ^+ indicates equal Λ and Σ parities with opposite K parity (K pseudoscalar). The possibility of evaluating the coupling constants from the low-energy behaviour of the K^--p cross-section is then briefly discussed.

539.12

7289. THE SELECTION RULES ON HYPERON DECAYS.

K.Nakagawa and H.Umezawa.
Nuovo Cimento, Vol. 10, No. 5, 911-12 (Dec. 1, 1958).

Assumption of the $|\Delta I| = \frac{1}{2}$ rule and invariance under time reversal leads to a different set of anisotropy coefficients in Σ decays, than had been accepted previously by the authors (Abstr. 2655/1959). The validity of the one-to-one law for the coupling constants is upheld; the calculated branching ratios and the ratios of the lifetimes do not disagree with the observed values.
S.J.St-Lorant

539.12

7290. PROTONIC DECAY OF Σ⁺ HYPERON WITH ASSOCIATED ELECTRON PAIR.

D.H.Davis, M.A.Shaukat and F.R.Stannard.
Nuovo Cimento, Vol. 11, No. 3, 468-9 (Feb. 1, 1959).

An event found in nuclear emulsion (European K^--stack collaboration) involving the in-flight decay of a Σ^+ hyperon according to $\Sigma^+ \rightarrow p + \pi^0$ is described. An electron pair is observed at the point of decay and it is inferred that it arises from the internal conversion of one of the two photons in the normal decay of the π^0 meson.
S.J.St-Lorant

539.12

7291. ANGULAR DISTRIBUTION OF THE DECAY PRODUCTS OF THE HYPERON.

J.M.Chen, T.H.Ho, D.C.Sen and H.Y.Tzu.
Scientia Sinica, Vol. 8, No. 3, 233-48 (March, 1959).

By assuming various forms of interaction Hamiltonian, the angular distribution of the decay products of spin ½ particle obeying the Dirac equation and that of spin 3/2 particle obeying the Rarita–Schwinger equation are calculated. The ratio of the strength of parity conserving and parity non-conserving interaction on the one hand, and the asymmetry parameter a on the other hand, is discussed. It is pointed out that if the vector and pseudo-vector coupling in the universal Fermi interaction proposed by Feynman and Gell-Mann are exactly equal to each other, then this theory gives an asymmetry parameter a of the Λ-decay, which is consistent with experimental results. However, if the ratio of the square of these two coupling constants is no longer equal to one, due to the renormalization effect, then the asymmetry parameter might be considerab modified. Thus the accurate determination of a will be useful to the investigation of the renormalization effect of the Feynman-Gell-Mann universal Fermi weak interaction. The angular distribution of the decay products of spin 3/2 particle obeying the Rarita-Schwinger wave-equation cannot be made to agree with the experimental result of the Λ particle decay.

539.12

7292. ON THE BRANCHING RATIOS OF THE DECAYS OF THE HYPERONS AND THE RATIOS OF THE MEAN LIFE TIMES.

J.M.Chen, T.H.Ho, D.C.Sen and H.Y.Tzu.
Scientia Sinica, Vol. 8, No. 3, 249-65 (March, 1959).

The branching ratios of the decays of the hyperons, the ratios of mean lifetimes of the decay of various hyperons and the ratios of the lifetime of the hyperons to that of the K-meson are calculated using the universal Fermi weak interaction proposed by Feynman and Gell-Mann, and the strong interaction proposed by Salam. The perturbation theory is used with a cut-off in the region of large momentum. By using the coupling constants of the strong interacti given by Warner, and choosing suitable values for the other two coupling constants remaining to be fixed, most of the results of the present calculation agree fairly well with experimental results. Th worst result differs from the experimental values at most by a factor of 2. The theoretical values of the branching ratios of K^+-decay is derived from this set of new coupling constants, showing better agreement with the experiment than the results obtained previously (see preceding abstract). The present calculation shows that the universal Fermi weak interaction of the V−A type gives quite a satisfactory explanation of the decay phenomena of K-meso and hyperons. It is also evident that these decays must be regarde as phenomena brought about by the joint action of strong and weak interactions and that there exist two classes of strong interactions the "very strong" and the "medium strong". The present results favour the assumption that the Λ- and the Σ-particles have the sa parity. It also shows that of the 4 terms of the strong interaction Hamiltonian given by Salam involving the K-meson at least two ter involve the γ_5 matrix.

539.12

7293. MASS OF THE CHARGED Σ HYPERONS. M.S.Swami.
Phys. Rev., Vol. 114, No. 1, 333-5 (April 1, 1959).

Twenty-nine examples of Σ^+ hyperon decays at rest into protons were used to determine the mass of the Σ^+ hyperon. The stopping power for each batch of emulsions containing these events was determined by making use of μ^+-meson ranges obtained from the decay of π^+-mesons at rest. The mean range of protons from Σ^+ decays was found to be 1686.5 ± 6.0 microns. The r.m.s. deviation was 37.2 ± 6.0 microns. The Q value for the decay ($\Sigma^+ \rightarrow p + \pi^0$) was found to be 116.37 ± 0.4 MeV and the mass of the Σ^+ hyperon, $(2328.1 \pm 0.8)m_e$. An analysis of three collinear events, which resulted from the interaction of stopped K^- mesons with hydrogen nuclei of the emulsion, gave the Σ^- hyperon mass as $(2341.6 \pm 2.0)m_e$ and the mass difference between Σ^- and Σ^+ hyperons $(13.5 \pm 2.0)m_e$.

539.12

7294. ON THE SPIN DEPENDENCE OF THE Λ-N INTERACTION.
L.E.Picasso and S.Rosati.
Nuovo Cimento, Vol. 11, No. 5, 711-17 (March 1, 1959).

The ratio w^j between the lifetimes for the decays $_\Lambda H^3 \rightarrow H^3 + \pi^-$ and $_\Lambda H^3 \rightarrow D + p + \pi^-$ has been calculated as a func-ion of the spin j of the $_\Lambda H^3$ ($j = \frac{1}{2}$ or $j = \frac{3}{2}$). The experimental value $w_{exp} <\sim 1$ favours $j = \frac{1}{2}$, showing that the Λ—N potential is more attractive in the singlet than in the triplet state. This result does not depend critically on the choise of the wave-functions, because $w^{3/2}/w^{1/2}$ is independent of it.

539.12

7295. DECAY OF $_\Lambda H^3$ AND THE SPIN DEPENDENCE OF THE Λ—NUCLEON INTERACTION. M.Leon.
Phys. Rev., Vol. 113, No. 6, 1604-7 (March 15, 1959).

A calculation is made of the fraction of the π-mesonic decays which yield the two final products He^3 and π^-. This fraction is a unction of the spin of $_\Lambda H^3$ and of the ratio p/s of the amplitudes for ecay of the free Λ via the s- and p-wave channels. The results are ompatible with the present experimental data. They indicate that robably $p/s \leq 1$, and that the spin of $_\Lambda H^3$ is $\frac{1}{2}$, which implies that the inglet Λ-nucleon interaction is more attractive than the triplet. These results are in agreement with those of a previous calculation by Dalitz for $_\Lambda H^4$ (Abstr. 2657/1959).

NUCLEUS

539.14 : 530.145

THE TWO-NUCLEON INTERACTION. See Abstr. 6532

539.14

296. REMARKS ON THE PROBABLE STRUCTURE OF NUCLEI AND OF SOME ELEMENTARY PARTICLES (BARYONS).
T.Vescan.
An. Stiint. Univ. "Al. I. Cuza" Iasi I (Ser. Noua), Vol. 3, No. 1-2, 57-62 (1957). In French.

Classical and relativistic considerations are used for an estimation of (1) the nuclear radius, (2) the charge density, (3) the dipole moment, and (4) a potential barrier of the form $r^{-1}e^{-K_0 r}$.

J.Lascoux

539.14

297. ON THE SHAPE OF EVEN ATOMIC NUCLEI.
Davydov and G.Filippov.
Nuclear Phys., Vol. 10, No. 6, 654-62 (May (1), 1959).

A nuclear model which consists of a core and of two nucleons n a shell of angular momentum j is considered. The energy as a unction of parameters β and γ is found for various values of the otal angular momentum of the nucleons. It is shown that if $j > \frac{3}{2}$ he shape for minimum energy of the nucleus in the ground state is ot axially symmetric. In the limit of very strong coupling of the ucleons to deformations of the nuclear surface, the equilibrium hape of the nucleus approaches one possessing axial symmetry.

539.14 : 539.17

EFFECTIVE MASS OF NUCLEON INSIDE NUCLEUS. MESON APTURE EXPERIMENTS. See Abstr. 6142

539.14

7298. EFFECT OF AN ODD-NUMBER NUCLEAR DEFORMATION ON THE ELECTRONIC STRUCTURE. M.Demeur and J.Lardinois.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 44, No. 11, 964-70 (1958).
In French.

The electric moments induced by a pear-shaped nuclear deformation were investigated. An odd multipole giving no radial excitation, the Sternheimer correction remains small.

539.14 : 539.163

INTERACTIONS OF NUCLEAR MOMENTS OF EXCITED STATES OF Cd^{111}. See Abstr. 6064

539.14

7299. NUCLEAR STRUCTURE EFFECTS IN INTERNAL CONVERSION COEFFICIENTS BY CONFIGURATION MIXING.
L.S.Kisslinger.
Phys. Rev., Vol. 114, No. 1, 292-304 (April 1, 1959).

The nuclear matrix elements which are needed to determine the internal conversion coefficients when a finite nucleus is employed are derived for nuclei for which the shell model wave-functions are a good zero-order approximation for low-energy processes. Using configuration mixing, general expressions are derived for these matrix elements. It is shown that the nuclear structure alteration can be 10-20% or more for l-forbidden transitions. Numerical results are given for the M1 and E2 279 keV transitions in Tl^{203}.

539.14

7300. INTERNATIONAL CONGRESS ON NUCLEAR SIZES AND DENSITY DISTRIBUTIONS.
Rev. mod. Phys., Vol. 30, No. 2(I), 412-584 (April, 1958).

For abstracts of some of the papers read at the above Conference see Abstr. 8588, 9009, 9012-16, 9064 (1958); 513, 529, 531, 571-81, 1715, 4968 (1959).

539.14

7301. DISTRIBUTION OF THE ANGULAR MOMENTA, LEVEL SPACINGS, AND NEUTRON WIDTHS OF Al^{28}. C.T.Hibdon.
Phys. Rev., Vol. 114, No. 1, 179-94 (April 1, 1959).

The neutron total cross-section from about 1 to 450 keV shows the presence of 66 peaks, seven of which are of the s-wave variety. Thirteen resonances are attributable to J = 0, twenty-one to J = 1, eighteen to J = 2, ten to J = 3, and three to J = 4. This distribution is in agreement with the theoretical distribution for a value of $2c\tau \equiv 2\sigma^2 = 6$. The density of all levels for this energy interval is 146 MeV^{-1} and the average level spacing of the nucleons is 0.48 MeV. The neutron widths vary from 1 to 7 keV and the distribution of the reduced widths appears to agree with an exponential distribution and is also in fair agreement with the Porter—Thomas distribution. The level spacings also agree with an exponential distribution. As obtained from the reduced widths averaged over both values of J, the value of the strength function for $l = 0$ is 0.05, averaged over all values of J for $l = 1$ it is 0.49, and for $l = 2$ it is too large in comparison with the p-wave strength function. The particularly low value of the cross-section below 30 keV and the shape of the wings of the 35 keV resonance can be explained by a multiple-level computation of the interference of the s-wave levels. On the basis of the results of the present analyses, the levels are about equally divided between the odd and even values of l.

539.14

7302. NUCLEAR ENERGY LEVELS AND MASS OF NITROGEN-17.
C.S.Littlejohn.
Phys. Rev., Vol. 114, No. 1, 250-5 (April 1, 1959).

Energy levels and the atomic mass defect of the nucleus N^{17} have been determined by measuring the kinetic energies of proton groups produced in the reaction $B^{11}(Li^7,p)N^{17}$ on bombardment of isotopically separated B^{11} targets with 2 MeV Li^7 ions. The protons were counted at 90°, in the laboratory system, from the forward direction of the lithium beam. The group of highest energy gave an (M—A) value of 12.92 ± 0.06 MeV for the N^{17} ground state, corresponding to a physical atomic weight of 17.01388 ± 0.00006. Two completely resolved groups of lower energy showed excited states at 1.32 and 1.89 MeV. Two strong but incompletely separated peaks showed levels at 2.50 and 2.82 MeV of excitation. Incompletely resolved groups of lower energy indicated four higher states at 3.27, 3.57, 3.86, and 4.18 MeV. Due to low counting rates, intensity estimates are difficult but indicate that, at 90° and 2 MeV bombardment, the ground-state group is only $\frac{1}{4}$ as strong as the most intense groups which arise from the 2.50 and 2.82 Mev levels. The groups from the higher levels (3.3-4.2 MeV) are less intense by a factor of

0.7. A comparison is made of the spectrum of N^{17} with O^{17} and F^{17}. Coulomb corrections are applied to calculate the isotopic spin $T = \frac{3}{2}$ sequence corresponding to the above levels in O^{17}, the lowest such level being predicted at 11.04 MeV in O^{17}. A brief discussion is given of the reaction and also of the interpretation in terms of nuclear shell structure of the levels observed.

539.14

7303. AN INVESTIGATION OF THE ENERGY LEVELS OF ^{26}Al.
S.Hinds and R.Middleton.
Proc. Phys. Soc., Vol. 73, Pt 3, 501-7 (March, 1959).

The energy levels were investigated by magnetic analysis using the reactions $Al^{27}(He^3,\alpha)Al^{26}$ and $Mg^{24}(He^3,p)Al^{26}$ at an incident energy of 5.8 MeV. The positions of 70 excited states of Al^{26} are reported below an excitation energy of 6.865 MeV. No evidence was found for a doublet at 2.08 MeV.

539.14

7304. THE ENERGY LEVELS OF ^{18}F. S.Hinds and R.Middleton.
Proc. Phys. Soc., Vol. 73, Pt 5, 721-6 (May, 1959).

The energy levels were investigated using the reactions $O^{16}(He^3,p)F^{18}$ and $F^{19}(He^3,\alpha)F^{18}$. In both cases magnetic analysis was employed and the incident He^3 energy was 5.9 MeV. The excitation energies of 40 levels were determined below 7.493 MeV.

539.14

7305. THE ENERGY LEVELS OF ^{15}O, ^{23}Mg AND ^{27}Si.
S.Hinds and R.Middleton.
Proc. Phys. Soc., Vol. 73, Pt 5, 727-32 (May, 1959).

The reactions $O^{16}(He^3, \alpha)O^{15}$, $Mg^{24}(He^3, \alpha)Mg^{23}$ and $Si^{28}(He^3, \alpha)Si^{27}$ were investigated at an incident energy of 5.8 MeV by magnetic analysis. The following levels were observed: O^{15}, 5.174, 5.233 MeV; Mg^{23}, 0.451, 2.048, 2.356, 2.712, 2.768, 2.904, 3.792, 3.856, 3.968 4.353 MeV; Si^{27}, 0.782, 0.958, 2.165, 2.651, 2.866, 2.908, 3.540, 3.800, (4.13) MeV.

539.14

7306. ON THE ROTATIONAL STATES OF NUCLEI. II. CALCULATION OF K [STATE] ADMIXTURE. G.Lüders.
Z. Naturforsch., Vol. 12a, No. 5, 353-62 (1957). In German.

In Pt I of this paper (Abstr. 8929/1956) the rotational state was examined in terms of the Bohr–Mottelson model [K. Danske Vidensk. Selsk. mat.-fys. Medd., Vol. 27, No. 6 (1953)] and it was found that the K-component of the total angular momentum is not a good quantum number on this model. In Pt II the consequences of this are worked out in terms of the K-admixture of the ground state and its influence on the static electric and magnetic multipoles. From this it is concluded that the Bohr–Mottelson model is consistent with the Inglis Model (Abstr. 1110/1955). J.W.Gardner

539.14

7307. COULOMB EXCITATION OF NEON.
D.G.Alkhazov, A.P.Grinberg, I.Kh.Lemberg and V.V.Rozhdestvenskiĭ.
Zh. eksper. teor. Fiz., Vol. 36, No. 1, 322-4 (1959). In Russian.

The Coulomb excitation of Ne^{20} and Ne^{22} nuclei by relatively slow protons (and larger nuclei) has been investigated. For both Ne^{20} and Ne^{22} the interaction exhibits resonances at 0.84 MeV and 1.01 MeV; for Ne^{22} a strong resonance also occurs at 1.275 MeV, and for Ne^{20} a weak resonance occurs at 1.63 MeV. These results may be interpreted in terms of a model consisting of closed shells plus one or two weakly bound nucleons. J.W.Gardner

539.14 : 539.163

ENERGY LEVELS IN Bi^{207} FROM THE DECAY OF Po^{207}.
See Abstr. 6063

539.14 : 539.17

NUCLEAR TEMPERATURE OF Mn AND Cu. See Abstr. 6129

539.14

7308. LIFETIMES OF THE FIRST EXCITED 0+ STATES OF Ca^{40} AND Zr^{90}. R.M.Kloepper, R.B.Day and D.A.Lind.
Phys. Rev., Vol. 114, No. 1, 240-9 (April 1, 1959).

The first excited states of Ca^{40} and Zr^{90} are 0+ states which decay to the 0+ ground state primarily by the emission of internal pairs or conversion electrons. These states have been excited by neutron inelastic scattering and their decay times have been observed by detecting the 0.51 MeV annihilation gamma-rays as a function of time. The experimental method utilized a pulsed neutron source and standard ring geometry often used for inelastic scattering measurements. Proton excitation of Ca^{40} in a different geometry was also used. To measure the lifetimes, the pulse-height spectra from a NaI(Tl) scintillation counter were recorded as a function of the delay time after the exciting pulse, and the intensity of the annihilation radiation was obtained from the area under the photopeak at 0.51 MeV. Selection of the time delays was made with aid of either a time-to-pulse-height converter or a fast coincidence circuit. Mean lives for the first excited states of Ca^{40} and Zr^{90} were found to be $(3.4 \pm 0.2) \times 10^{-9}$ sec and $(90 \pm 6) \times 10^{-9}$ sec, respectively. Corresponding values of the reduced matrix elements ρ are 0.15 and 0.056.

539.14 : 539.18

7309. CHARGE DISTRIBUTION OF EXCITED ISOMERIC NUCLEI AND ATOMIC SPECTRA (THE NUCLEAR ISOMERIC SHIFT).
R.Weiner.
Phys. Rev., Vol. 114, No. 1, 256-60 (April 1, 1959).

Attention is called to a characteristic of excited nuclei so far almost unstudied, neither theoretically nor experimentally — namely the charge distribution. The comparison of the charge distributions of two isomeric nuclei is automatically realized in atomic spectra, giving rise to the nuclear isomeric shift on spectral lines. Some general theoretical aspects of this effect are discussed here. Only odd nuclei with optical protons are studied. It is assumed (A) that the transitions are single-particle ones, and (B) that the Rosenthal–Breit perturbation theory is valid. Under these assumptions it is shown that but for the sign, the effect is a pure single-particle effect, given by the optical protons. The sign of the shift is generally intimately related to the whole nuclear configuration. In the case of two characteristic transitions it is shown that the order of magnitude of the effect does not depend on the shape of nuclear potential. By specializing to two particular forms of nuclear potential (harmonic oscillator and infinite square well), it is shown that there exists a very simple relation between the shift and the characteristics of the two nuclear states involved. Numerical applications are given for In^{115}III and Au^{197}I. The theoretical value of the effect is clearly within the reach of atomic spectroscopy ($\geq 10^{-3}$ cm^{-1}).

RADIOACTIVITY

539.16 : 621 362

7310. THE AMERICAN MINIATURE NUCLEAR GENERATOR, SNAP III. W.S.Eastwood, L.B.Mullett and J.L.Putman.
Nature (London), Vol. 183, 643-4 (March 7, 1959).

Description and discussion of a ~ 10 W electricity generator using Po^{210} which heats PbTe thermocouple junctions.

R.S.Pease

539.16.08

7311. ON THE DETERMINATION OF THE ISOTOPIC CONTENT RATIO U^{238}/U^{234} WITH AN ALPHA-SPECTROMETER. F.I.Havlíček
Nuovo Cimento, Vol. 11, No. 2, 198-211 (Jan. 16, 1959). In German

The arrangement consists of an argon–nitrogen filled gridded ionization chamber for electron collection, preamplifier, linear amplifier, single-channel analyzer, and decade scaler. Detailed description is given of the ionization chamber and the filling procedure, of the associated electronic equipment and of the method of preparation of the uranium source which is electrolytically deposite in the form of thin layers. The accuracy if the measurements is discussed in connection with the determination of the uranium isotopic concentration ratio after evaporation of UF_6.

I.C.Demetsopoullos

539.163

7312. FRACTIONAL PARENTAGE COEFFICIENTS FOR MIXED CONFIGURATIONS IN LS COUPLING. P.Kelly and B.H.Armstrong
Astrophys. J., Vol. 129, No. 3, 786-93 (May, 1959).

An explicit general formula is presented for the magnitudes of the fractional parentage coefficients of mixed configurations and particular formulae for the cases of two and three angular-moment mixtures. Approximately nine hundred fractional parentage coefficients are tabulated for twenty-six different three angular-momenta configurations.

539.163

7313. RADIOACTIVE DECAY OF Au^{200}. J.C.Roy and L.P.Roy.
Canad. J. Phys., Vol. 37, No. 4, 385-95 (April, 1959).

The half-time of Au^{200} was measured to be 48.4 ± 0.3 min. The beta radiations emitted in the decay were studied by absorption in aluminium, and the gamma radiations with a multichannel scintillation spectrometer. Two beta rays with end-point energies of 2.25 ± 0.20 and 0.7 ± 0.1 MeV and respective abundance of (75 ± 3)% and (25 ± 3)% were detected. Three gamma rays with energies of 0.367, 1.23, and 1.60 MeV were observed. It was established that the 0.367 and 1.23 MeV gamma rays are in coincidence. A decay scheme for Au^{200} is proposed.

539.163

7314. THE RADIOACTIVITY OF ARGON-37.

R.W.Kiser and W.H.Johnston.

J. Amer. Chem. Soc., Vol. 81, No. 8, 1810-13 (April 20, 1959).

Proportional counter spectroscopy has been utilized in the investigation of the electron capture processes. From quantitative measurements of the K- and L-capture of A^{37} in various counters using a number of different gases, the L/K-capture ratio was determined to be 0.102 ± 0.008. Recent results which might indicate that the L/K-capture ratio might be significantly greater than 0.10 are discussed. Measurements show that double K-vacancies occur to the extent of $(3.7 \pm 0.9) \times 10^{-4}$ of K-capture events. The half-life of A^{37} against decay was observed to be 34.30 ± 0.14 days.

539.163

7315. DECAY PROPERTIES OF I^{136}.

N.R.Johnson and G.D.O'Kelley.

Phys. Rev., Vol. 114, No. 1, 279-85 (April 1, 1959).

I^{136}, produced from the slow neutron fission of uranium, has been studied with scintillation techniques. From the single-crystal (NaI) and gamma—gamma coincidence spectra, gamma-rays were found at energies of 0.20, 0.27, 0.39, 0.46, 0.53, 0.71, 1.00, 1.321 ± 0.006, 1.55, 1.72, 1.91, 2.25, 2.40, 2.63, 2.84, and 3.2 MeV. Also from single-crystal (anthracene) and beta—gamma coincidence measurements, four beta-ray groups were observed with energies of 2.73, 4.23, 5.62, and 7.00 MeV, where the latter represents the I^{136}—X^{136} mass difference and is present in about 6% of the total beta-ray transitions. A partial decay scheme has been proposed, with energy levels in Xe^{136} at 1.32, 2.64, 2.84, 3.03, 3.23, 3.57, 3.74, and 4.20 MeV. The half-life of I^{136} was measured at 82.8 ± 1.5 sec. In the course of this investigation a source of 3.8 min Xe^{137} was prepared, and was found to emit prominent gamma-rays of 0.26 and 0.45 MeV.

539.163.1

7316. DETERMINATION OF THE HALF-LIFE OF THE FIRST EXCITED STATE OF Cd^{111}. A.Maier and K.P.Meyer.

Helv. phys. Acta, Vol. 30, No. 7, 611-38 (1957). In German.

The lifetime of the first excited state of Cd^{111} was remeasured with high precision. The half-life is 84.1 ± 0.5 mμsec. Interest in remeasuring this number was stimulated by the fact that, together with angular correlation measurements, it yields the magnetic moment of the first excited state of Cd^{111}. The measurement was carried out by using the delayed coincidences of the conversion electrons of the 172-247 keV γ-cascade. The evaluation of possible systematic errors of the method and the arranging of the experiments in such a way as to minimize these errors were especially emphasized. No corrections greater than 0.2 mμsec had to be introduced in the determination of the final result. As side results, a more precise value of the half-life of In^{111} (2.81 ± 0.01 days) was measured, and a slow component in the light-emission of a commonly used plastic scintillator was found (intensity 1.7%, half-line 2.2 μsec).

539.163.1

7317. ON THE HALF-LIFE OF Tl^{204}. R.W.Fink and B.L.Robinson.

Nuclear Phys., Vol. 10, No. 1, 82-7 (Feb. (1), 1959).

Samples of Tl^{204} produced in different irradiations and of varying ages were counted in an end-window methane-flow beta-proportional counter for a period of 1.4 years. The decay curves for these samples are identical, and the average value of the half-life is 3.7 ± 0.04 years. Intercomparison of the ratio of K X-rays to beta-bremsstrahlung and of L X-rays to beta-bremsstrahlung between young (few months) and aged (6 years) reactor-produced, high specific activity solutions of Tl^{204} exhibited no differences which might arise from the presence of a long-lived isomeric state in thallium. Previous results are summarized.

539.163.2 : 539.14

7318. LEVEL SCHEME OF Ta^{181}.

P.Debrunner, E.Heer, W.Kündig and R.Rüetschi.

Helv. phys. Acta, Vol. 29, No. 5-6, 463-506 (1956). In German.

By means of angular correlation methods, the decay of Hf^{181}—Ta^{181} was studied. Spins and parities of all levels are discussed and compared with the predictions of the unified model. The angular correlation of the main γ-γ cascade (133-482 keV) was investigated using cubic crystalline, liquid and gaseous sources. The angular correlation of two other cascades, inseparables in energy by scintillation techniques, was measured making use of the different attenuation in various sources. The magnetic moment of the 482 keV level was determined, taking into account the attenuation effects in liquids. All experimental data, including Coulomb excitation and the decay of W^{181}, are summarized.

539.163.2 : 539.14

7319. NUCLEAR-SPECTROSCOPIC INVESTIGATION OF THE RADIOACTIVE ISOTOPES Hg—Au^{195} and Hg—Au^{193}.

J.Brunner, J. Halter and P.Scherrer.

Helv. phys. Acta, Vol. 31, No. 4, 335-78 (1958). In German.

The decays of $Hg^{193,195}$ were investigated using β- and γ-spectroscopy and coincidence techniques. The resulting level schemes of Au^{195} and Au^{193} are compared with the predictions of the nuclear models (shell model and collective model). For most levels spin and parity are determined and proton configurations are derived from considerations based on the shell model. The level schemes of $Au^{193,195,197}$ show remarkable analogies up to energies of about 1.5 MeV.

539.163.2

7320. ON THE DECAY OF XENON 133.

S.Jha, H.G.Devare, M.Narayana Rao and R.M.Singru.

Nuovo Cimento, Vol. 11, No. 6, 788-92 (March 16, 1959).

The γ-rays from Xe^{133} have been studied in a scintillation spectrometer. The γ-rays have the energy of 80 keV, 160 keV, 300 keV and 380 keV with the relative intensity 1, 1.4×10^{-2}, 8.4×10^{-4} and 4.3×10^{-4}. By studying the 80 keV γ-rays in coincidence, the relative intensity of the cascade and the cross-over transition from the 160 keV state has been found. Taking this into account, the log ft values for the β-transition to the 80 keV, 160 keV and 380 keV states have been calculated to be 5.6, 7 and 5.7 respectively.

539.163.2

7321. THE DISINTEGRATION OF Ga^{73}. L.Marquez, E.W.Cybulska, N.L.Costa, I.G.Almeida and J.Goldemberg.

Nuclear Phys., Vol. 10, No. 1, 28-32 (Feb. (1), 1959).

The disintegration of Ga^{73} was studied using gamma ray spectrometers, both alone and in coincidence; and by the absorption of the beta rays in coincidence with the most prominent gamma ray in the scintillation spectrometer. It was found that there were two gamma rays; one with an energy of 310 keV and intensity of about 90%, the other with an energy of 740 keV and an intensity of about 7%. A self-consistent decay scheme is proposed showing one beta ray of 550 keV and intensity of about 7%, a second beta ray of 1300 keV and intensity of about 83%, and perhaps a third beta ray of 1600 keV and intensity of about 10%. All beta rays lead to the metastable state of Ge^{73}.

539.164.2

7322. ALPHA-DECAY BARRIER PENETRABILITIES WITH AN EXPONENTIAL NUCLEAR POTENTIAL: EVEN—EVEN NUCLEI.

J.O.Rasmussen.

Phys. Rev., Vol. 113, No. 6, 1593-8 (March 15, 1959).

The real potential derived by optical-model analysis of data on elastic scattering of alpha particles is used for calculation of barrier penetrabilities for all known alpha decay groups of even—even nuclei. The barrier penetration factors were calculated by numerical integration in the WKB approximation taking into account centrifugal barrier effects, but ignoring noncentral interactions. Using these penetration factors and the experimental alpha half-lives, the reduced level widths δ^2 are calculated. Ratios of δ^2 values for ground and excited-state alpha groups are tabulated as a set of reduced hindrance factors.

539.165 : 539.14

7323. DE-EXCITATION OF Ir^{192} BY MEASURING THE β—γ DIRECTIONAL CORRELATION.

J.P.Deutsch, G.Doumont and P.C.Macq.

Ann. Soc. Sci. Bruxelles I, Vol. 72, No. 3, 192-7 (1958).

Directional correlation measurements on Ir^{192} beta—gamma cascades fix the angular momentum of Ir^{192} ground state at 5. This determination does not use the controversial results of gamma—gamma directional correlation measurements on Pt^{192}.

539.165 : 539.1.07

7324. SECTOR TYPE DOUBLE FOCUSING BETA RAY SPECTROMETER. II. TWIN SETTING MEASUREMENT OF THE WEAK HIGHER COMPONENT OF Cs^{137}.
T.Yamazaki, H.Ikegami and M.Sakai.
J. Phys. Soc. Japan, Vol. 13, No. 10, 1080-3 (Oct., 1958).

A twin setting of two sector-type double-focusing beta ray spectrometers was used. The measured spectrum agreed well with those of the previous results.

539.165

7325. LOW-INTENSITY CONVERSION LINES FROM Sm^{151} AND Sn^{113}. W.T.Achor, W.E.Phillips, J.I.Hopkins and S.K.Haynes.
Phys. Rev., Vol. 114, No. 1, 137-42 (April 1, 1959).

The electron spectrum of Sm^{151} was measured with a lens spectrometer and its gamma-ray spectrum with a scintillation spectrometer. The L-conversion coefficient of the 21.7 ± 0.3 keV de-excitation of the first excited state of Eu^{151} is 20 ± 4, with $(\alpha_L/\alpha_{M+N}) = 2.2 \pm 0.4$ and $\alpha_M/\alpha_N = 2.2 \pm 0.2$ indicating M1 multipolarity. The low intensity of the conversion electrons relative to the continuous beta spectrum of end point 75.9 ± 0.6 keV implies the existence of a weak beta transition whose end point is 54.2 ± 0.7 keV. The beta branching ratio, 54.2 keV beta transitions/75.9 keV beta transitions, is 1.7/100. $\text{Log}_{10}ft$ values for the two beta decays are 7.6 ± 0.2 for the 75.9 keV decay and 8.8 ± 0.2 for the 54.2 keV decay. A partial analysis of the decay in terms of the Nilsson—Gottfried scheme was made, but no definitive assignment for the 21.7 keV state appears to be possible. Measurements of the electron spectrum of Sn^{113} with the lens spectrometer reveal the existence of a weak conversion line corresponding to a transition of 253 keV. The intensity of this conversion line is $(2.8 \pm 1.0) \times 10^{-3}$ of the intensity of the conversion line from the 392 keV transition. This relative conversion-electron intensity indicates that the 253 keV transition leads to the 392 keV state of In^{113}, implying the existence of an excited state at 645 keV. The existing uncertainty in the relative gamma-ray intensities for the two transitions makes it impossible to assign spin and parity to the 645 keV state; the decay scheme presented is therefore incomplete.

539.165

7326. L/K-CAPTURE RATIO IN ^{195}Au.
A.Bisi, E.Germagnoli and L.Zappa.
Nuovo Cimento, Vol. 11, No. 6, 843-9 (March 16, 1959).

The L/K-capture ratio in orbital electron capture decay of Au^{195} was investigated by using a measurement procedure based on coincidence techniques. It was found for the transition to the 128 keV level of Pt^{195}: $P_L/P_K = 5.5 \pm 0.9$ which corresponds to a transition energy of 106 keV. In addition a determination of the half-life of Au^{195} and of the K conversion coefficient of the 97 keV transition was made. It was obtained $T_{1/2} = (192 \pm 5)$ d and $\alpha_K = 8.4 \pm 0.5$. The proposed decay scheme agrees quite well with previous results.

539.165.2

7327. HIGHER ORDER CORRECTIONS TO THE ALLOWED BETA DECAY. M.Morita.
Phys. Rev., Vol. 113, No. 6, 1584-9 (March 15, 1959).

The shape of the allowed beta spectrum and the directional correlations of the allowed beta-ray and gamma- or alpha-ray were investigated theoretically with an assumption of VA. The treatment takes into account the Coulomb field due to the daughter nucleus, the finite de Broglie wavelength effect, and the contribution of the second forbidden matrix elements, $\mathfrak{M}(r^2)$, $\mathfrak{M}(\alpha.r)$, $\mathfrak{M}(\sigma r^2)$, $\mathfrak{M}(\sigma.r)r$, $\mathfrak{M}(\gamma_5 r)$, and $\mathfrak{M}(\alpha \times r)$, simultaneously. Relations between coordinate-type and momentum-type matrix elements are given in the nonrelativistic approximation. In this case, $\mathfrak{M}(\alpha \times r)/\mathfrak{M}(\sigma) = M^{-1}$. The correction factors for the beta spectra of B^{12} and N^{12} as well as their ratio have almost no energy dependence, since several corrections cancel each other. On the other hand, this ratio varies by 12% over the whole spectrum, if $\mathfrak{M}(\alpha \times r)/\mathfrak{M}(\sigma) = M^{-1}(\mu_p - \mu_n)$ is adopted as given by Gell-Mann. The beta-alpha directional correlation of Li^8 is discussed also.

539.165.2

7328. INFLUENCE OF FINITE NUCLEAR SIZE ON EFFECTS CONNECTED WITH PARITY NON-CONSERVATION IN BETA DECAY.
B.V.Geshkenbeĭn.
Zh. eksper. teor. Fiz., Vol. 33, No. 6(12), 1535-6 (1957). In Russian. English translation in: Soviet Physics — JETP (New York), Vol. 6(33), No. 6, 1187-9 (June, 1958).

The influence on longitudinal electron polarization and electron—neutrino angular correlation is considered. R.J.N.Phillips

539.166

7329. MEASUREMENTS OF THE γ-RADIATIONS FROM Eu^{152} BY THE METHOD OF EXTERNAL CONVERSION.
O.Nathan and S.Hultberg.
Nuclear Phys., Vol. 10, No. 2, 118-34 (Feb. (2). 1959).

The photoline spectrum from 10 γ-rays following the decay of 12 yr Eu^{152} was studied with a double-focusing β-spectrometer, using a 2.2 mg/cm² U converter. The resulting momentum resolution was 0.6-1%, depending on energy. The relative γ-ray intensities found are in good agreement with those obtained by Dželepow and Zhukovsky from a study of recoil electrons. Combining the present γ-ray intensities and the internal conversion data of Bobykin and Novik, relative values of internal conversion coefficients of the investigated γ-rays were determined. The multipolarity assignments obtained in this way are discussed within the framework of the unified model, and particular attention is given to the 689 keV transition in Sm^{152}. It is suggested that this radiation is of the E0 + E2 type and is proceeding from a proposed 2 + β-vibrational state at 811 keV to the 2+ member of the ground-state rotational band. The decay properties of the 811 keV state are discussed in some detail.

539.166

7330. RADIATIONS FROM Tb^{156}.
J.T.Holloway and L.J.Laslett.
Phys. Rev., Vol. 113, No. 6, 1581-3 (March 15, 1959).

The decay of Tb^{156} was studied following its production by the $Tb^{159}(\gamma,3n)Tb^{156}$ reaction with 64 MeV bremsstrahlung. In the 5.6 day activity, 18 gamma transitions were detected with energies between 89 and 2060 keV. The K X-radiation of Gd was associated with this activity, while no Dy radiation was found. No annihilation radiation was detected. The gamma spectrum was observed in coincidence with the Gd X-ray and found to be closely similar to that observed alone. No evidence of β-decay was found and it is concluded that the observed decay is by orbital electron capture. A relatively weak 5.5 hr activity, ascribable to Tb^{156m}, was also produced by the $(\gamma,3n)$ reaction.

539.166

7331. DISINTEGRATION OF Ag^{110m}. H.W.Taylor and S.A.Scott.
Phys. Rev., Vol. 114, No. 1, 121-6 (April 1, 1959).

The gamma radiations were studied using a conventional scintillation coincidence spectrometer and the gamma-ray summing technique. The positions of the 1484, 735, and 1560 keV gamma rays in the decay scheme were determined.

539.166

7332. GAMMA—GAMMA DIRECTIONAL CORRELATION IN Cd^{110}.
H.W.Taylor and W.R.Frisken.
Phys. Rev., Vol. 114, No. 1, 127-32 (April 1, 1959).

Directional correlation experiments were performed for the 1385-885, 760-1510, and 940-885 keV gamma-ray cascades in Cd^{110}. Spins of 5, 6, 3, 4 have been assigned to the levels at 2935, 2490, 2170 and 1540 keV in the Cd^{110} level scheme. The 1385 and 1510 keV gamma-rays are dipole—quadrupole mixtures.

539.166

7333. 0-600 keV GAMMA-RAY SPECTRA FROM THERMAL NEUTRON CAPTURE IN THE REGION A = 104 TO 198. J.E.Draper
Phys. Rev., Vol. 114, No. 1, 268-78 (April 1, 1959).

The energies and absolute intensities of prominent peaks in the 0-600 keV region of the gamma-ray spectrum following thermal neutron capture have been measured with a single NaI(Tl) scintillation spectrometer. The elements investigated were rhodium, silver, cadmium, indium, antimony, tellurium, iodine, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, hafnium, tantalum, rhendium, iridium, platinum and gold.

539.166

7334. MASS DETERMINATION AND THE γ-SPECTRUM OF 22 MIN LUTETIUM. T.Stribel.
Z. Naturforsch., Vol. 12a, No. 6, 519-20 (1957). In German.

It is concluded that the 22 min activity of the product of the $Hf^{179}(\gamma,p)$ reaction found by Butement (Abstr. 4350/1950), is in fact due to the γ-activity of lutetium-178 of half-life 18.7 ± 0.5 min. Two lines of γ-energy 342 ± 3 and 445 ± 5 keV are shown to be the principal components of the decay spectrum. S.J.St-Lorant

NUCLEAR REACTIONS

539.17

7335. GAMMA RADIATION FROM THE CAPTURE OF 5 to 7.7 MeV PROTONS IN F^{19}, Na^{23}, Al^{27} and P^{31}.
D.S.Gemmell, A.H.Morton and W.I.B.Smith.
Nuclear Phys., Vol. 10, No. 1, 45-52 (Feb. (1), 1959).

Pronounced resonances were observed in the yield of gamma rays with variation of proton energy from 5 to 7.7 MeV in steps of 70 keV for the reactions $F^{19}(p,\gamma)Ne^{20}$, $Na^{23}(p,\gamma)MG^{24}$, $Al^{27}(p,\gamma)Si^{28}$ and $P^{31}(p,\gamma)S^{32}$. The energy of the protons from the Canberra cyclotron was changed by interposing aluminium foils in the beam. Gamma-ray yields for transitions to the ground and first excited states of the product nuclei were measured using a large sodium iodide crystal spectrometer. Estimates of the appropriate cross-sections for these reactions are given.

539.17

7336. FORMATION OF Be^7 IN INTERACTIONS OF VARIOUS NUCLEI WITH HIGH-ENERGY PROTONS.
E.Baker, G.Friedlander and J.Hudis.
Phys. Rev., Vol. 112, No. 4, 1319-21 (Nov. 15, 1958).

Cross-sections are reported for the formation of Be^7 in interactions of C, Al, Cu, Ag, and Au with protons of energies between 0.1 and 3 BeV. They are compared with previous data at 0.34 BeV proton energy. The carbon cross-section is strikingly constant at 11 to 14 mb from 0.1 to 3.0 BeV. The other cross-sections rise with increasing proton energy and are all in the neighbourhood of 10 mb at 3 BeV. Be^7 may be considered as a spallation residue from carbon, and the same mechanism probably accounts for at least a large part of its formation from Al. However, Monte Carlo calculations show that this mechanism predicts much too low cross-sections from the higher Z targets. Other mechanisms must be invoked, the most promising being the evaporation of Be^7 nuclei (see the following abstract).

539.17

7337. Be^7 NUCLEI AS EVAPORATED PARTICLES IN HIGH-ENERGY REACTIONS. J.Hudis and J.M.Miller.
Phys. Rev., Vol. 112, No. 4, 1322-5 (Nov. 15, 1958).

The probability for the emission of Be^7 nuclei in an evaporation process is calculated. These calculations support the hypothesis that the Be^7 produced in high-energy proton irradiation of copper, silver, and gold (see preceding abstract) is formed directly by an evaporation process.

539.17

7338. INELASTIC SCATTERING OF PROTONS BY VARIOUS NUCLEI. T.Tamura and D.C.Choudhury.
Phys. Rev., Vol. 113, No. 2, 552-62 (Jan. 15, 1959).

Experimental data on the inelastic scattering of 23-MeV protons reported by Cohen, Mosko, and Rubin (See Abstr. 4714, 7373/1957; 5038/1959) are analysed by using the theory of direct interaction together with the plane wave approximation. The most detailed analysis is done for lead isotopes and, at least at 90°, it is found that fairly good agreement with experiment is obtained for the relative magnitudes of the excitation of different excited states. The same idea is also applied to other cases and in particular several arguments are given which will support the view of Lane and Pendlebury for associating the anomalous peaks observed at ~2.5 MeV for nuclei with Z = 30-53 with the octupole surface vibrations. Finally discussions are given of the validity of the approximations used in the present analysis and also of the circumstances which still need more refined calculations.

539.17

7339. DIRECT-INTERACTION MODEL CALCULATION OF HIGH-ENERGY PROTON–CARBON SCATTERING. A.H.Cromer.
Phys. Rev., Vol. 113, No. 6, 1607-14 (March 15, 1959).

An optical potential has been derived which includes, to first order in q^2, the effect of the nucleon–nucleon angular dependence. Nucleon–nucleon scattered amplitudes calculated from the 310 MeV nucleon–nucleon phase shifts have been put into the potential and the proton–carbon scattered amplitudes calculated from it by WKB approximation. Good agreement was obtained with the scattered amplitudes as derived directly from the 313 MeV proton–carbon data using an extension of the analysis employed previously by Bethe. The inclusion of the nucleon–nucleon angular dependence in the potential was found to be important in order to obtain the correct value of the imaginary part of the forward scattered amplitude and the correct proton–carbon angular dependence at moderately small angles. Phase shift solutions 1 and 6 of Stapp et al. were investigated and found to give essentially the same agreement with the differential cross-section at small angles. Solution 6 was found to give a better fit to the polarization data than solution 1, but the significance of this is not clear.

539.17

7340. POLARIZATION OF NEUTRONS FROM $Li^7(p,n)Be^7$ AND FROM n–d SCATTERING. L.Cranberg.
Phys. Rev., Vol. 114, No. 1, 174-5 (April 1, 1959).

The polarization was examined by using n–He^4 scattering as an analyser and the pulsed-beam time-of-flight technique as a neutron spectrometer. Results are reported up to 4.95 MeV proton energy. The data include results on the neutron groups corresponding to Be^7 being left in its ground state and first excited state. Using neutrons of 2.1 MeV which are polarized 38%,the polarization for n–d scattering at several angles has been found to be less then 0.07, which is consistent with a prediction by Christian and Gammel of negligible polarization.

539.17

7341. T(p,p)T SCATTERING NEAR THE $T(p,n)He^3$ THRESHOLD.
N.Jarmie and R.C.Allen.
Phys. Rev., Vol. 114, No. 1, 176-8 (April 1, 1959).

The absolute cross-section of T(p,p)T elastic scattering at centre-of-mass angles of 58° 38' and 109° 31' was measured as a function of energy near the $T(p,n)He^3$ threshold. Small but distinct perturbations are observed near the threshold and are discussed in the light of theoretical predictions. The bearing of the data on a possible excited state in He^4 at 20 MeV is discussed.

539.17

7342. $C^{13}(p,\gamma)N^{14}$ 1.47 AND 2.11 MeV RESONANCES AND THE ODD-PARITY LEVELS OF MASS 14.
E.K.Warburton, H.J.Rose and E.N.Hatch.
Phys. Rev., Vol. 114, No. 1, 214-40 (April 1, 1959).

A study has been made of the γ-rays emitted by the 8.9 and 9.5 MeV levels of N^{14} using the $C^{13}(p,\gamma)N^{14}$ reaction at the 1.47 and 2.11 MeV resonances. The decay schemes of these levels were reinvestigated using a three-crystal pair spectrometer, NaI(Tl) single crystal measurements, and standard $\gamma-\gamma$ coincidence techniques. The anisotropies relative to the bombarding beam of most of the observed γ transitions were measured using the three-crystal pair spectrometer. The angular distributions of some of the γ transitions were measured using a single NaI(Tl) crystal. Measurements were made of the Doppler shifts of the ground state decay of the N^{14} 5.10 MeV level and the cascade from the N^{14} 5.83 MeV level to the N^{14} 5.10 MeV level. From these Doppler shift measurements the mean lifetime of the N^{14} 5.83 MeV level was found to be in the range $(5\text{-}65) \times 10^{-14}$ sec; while an upper limit of 3×10^{-13} sec was set on the mean life of the N^{14} 5.10 MeV level. The results of the study of the γ decay of the N^{14} 9.5 and 8.9 MeV levels combined with the results of earlier measurements give conclusive assignments of 2^-, 3^-, 3, and 2 for the N^{14} levels at 9.50, 8.90, 5.83, and 5.10 MeV. The 5.83 MeV level most probably has odd parity. A tentative assignment of J = 2 is given to the N^{14} 7.02 MeV level. Evidence is presented, from this and previous investigations, that indicates the N^{14} 8.06 8.70, 8.90, and 9.50 MeV levels arise from the $s^4p^8 2s$ and $s^4p^9 d$ configurations with the largest contribution being from the $(p_{1/2}2s_{1/2})$ configuration for the 8.90 and 8.70 MeV levels and from the $(p_{1/2}d_{5/2})$ configuration for the 8.90 and 9.50 MeV levels. The analogues of these T = 1 levels in C^{14} are almost certainly the C^{14} 6.09, 6.89, 6.72 and 7.35 MeV levels, respectively. The T = 0, $s^4p^8 2s$ and $s^4p^9 d$ states of N^{14} are also discussed. It is proposed that the 4.91, 5.69, 5.10 and 5.83 MeV levels of N^{14} are 0^- and 1^-, $s^4p^9 2s_{1/2}$ and 2^- and 3^-, $s^4p^9 d_{5/2}$ states, respectively.

539.17

7343. NUCLEAR PARAMETERS IN THE SCATTERING OF NUCLEONS BY CARBON. R.Wilson.
Phys. Rev., Vol. 114, No. 1, 260-7 (April 1, 1959).

Scattering of protons and neutrons by carbon at small angles is discussed. It is shown that it is not possible to obtain a coherent understanding of the scattering at 310 MeV without including an increase of the radius due to nuclear forces. The increase required is in rough agreement with that calculated from nucleon–nucleon scattering. At 135 MeV, where more complete data are available, it is shown that this increase is not sufficient to obtain a coherent understanding. Either approximations break down, or there is a difference in the scattering of neutrons and protons in addition to the Coulomb forces. Further, small-angle polarization measurements are badly needed at both energies.

539.17

7344. CROSS SECTIONS FOR NUCLEAR REACTIONS INVOLVING NUCLEAR ISOMERS. B.Linder and R.A.James.
Phys. Rev., Vol. 114, No. 1, 322-5 (April 1, 1959).

Cross-sections for the reactions $Cr^{52}(p,n)Mn^{52m}$, $Cr^{52}(p,n)Mn^{52}$, $Ag^{107}(p,pn)Ag^{106m}$, $Ag^{107}(p,pn)Ag^{106}$, and $Cu^{63}(p,n)Zn^{63}$ were determined as a function of energy with the 20.6 MeV proton beam of the U.C.L.A. synchrocyclotron. The relative yields of Sr^{85}, Sr^{85m}, and Sr^{87m} obtained in the proton bombardment of rubidium were also determined. In all cases the isomer yield ratios varied with energy over the entire energy range studied. The results are discussed in terms of conservation of angular momentum, assuming compound nucleus formation.

539.17

7345. HIGH-ENERGY PHOTOPROTONS FROM SILVER.
K.H.Lokan.
Proc. Phys. Soc., Vol. 73, Pt 5, 697-704 (May, 1959).

The energy distributions and absolute yields of photoprotons of energy greater than 10 MeV from silver have been measured for maximum bremsstrahlung energies between 16 and 32 MeV. The derived cross-section for this component, which may be identified as arising from direct interactions, passes through a maximum at about 22 MeV, and the integrated cross-section is found to be (36 ± 9) MeV mb. This result is consistent with the idea that most of the emission arises from a 2p—2d transition at 22 MeV, and this interpretation is supported by the angular distribution measured at 30 MeV, which is strongly anisotropic.

539.17

7346. THE REACTIONS $^{27}Al(p,p')^{27}Al$ AND $^{27}Al(\alpha,p)^{30}Si$.
F.de S.Barros, P.D.Forsyth, A.A.Jaffe and I.J.Taylor.
Proc. Phys. Soc., Vol. 73, Pt 5, 793-9 (May, 1959).

These reactions were studied at 5 MeV incident energy using a high resolution broad range magnetic spectrograph. Angular distributions of several of the proton groups from each of the reactions were determined and the results suggest that some of the final states are formed by direct processes. The excitations of the first four states of Si^{30} were found to be 2.258 ± 0.006, 3.518 ± 0.007, 3.798 ± 0.009 and 4.85 ± 0.01 MeV.

539.17

7347. ANALYSIS OF THE REACTION $C^{13}(He^3,\alpha)C^{12}$.
G.E.Owen, L.Madansky and S.Edwards, Jr.
Phys. Rev., Vol. 113, No. 6, 1575-80 (March 15, 1959).

The angular distributions of the alpha-particles from the reaction $C^{13}(He^3,\alpha)C^{12}$ at 4.5 and 2.0 MeV were analysed from the point of view of nuclear stripping. By symmetrizing the wave-function of the complete Hamiltonian with respect to the exchange of alpha-particles, the heavy-particle stripping amplitude is formally included. The experimental distributions change decidedly between 2.0 and 4.5 MeV, and the calculated curves employing a combination of pickup and α-stripping from C^{13} agree quite well with the experimental distributions. Interference between the two channels plays a major role in the final expressions.

539.17

7348. THE STRIPPING REACTION OF ^3He AND ALPHA PARTICLES. M.El Nadi and M.El Khishin.
Proc. Phys. Soc., Vol. 73, Pt 5, 705-12 (May, 1959).

The recent experimental data on the (He^3,p) differential cross-section showing forward and backward peaks are interpreted as due to the He^3 particle stripping and heavy particle stripping respectively. Reasonable agreement is obtained between the derived theoretical formulae and the experimental data. Some (d,α) reactions are interpreted in a similar way.

539.17

7349. SCATTERING OF 20 MeV α-PARTICLES.
H.W.Fulbright, N.O.Lassen and N.O.R.Poulsen.
K. Danske Vidensk. Selsk. Mat.-fys. Medd, Vol. 31, No. 10, 40 pp. (1959).

Focusing and analysing magnets for bringing the external beam of a cyclotron into a shielded room were constructed. An ionization chamber for detecting scattered α-particles was constructed and the set-up was found to give a resolution of about 1% in energy. The scattered energy spectra were measured at 45°, 90°, and 135° for a number of elements. Peaks due to direct interaction processes were observed in all elements except the heaviest, where the α-particles cannot penetrate the barrier. Energy distributions corresponding to α-particles evaporated from the compound nucleus were observed for Ni, Cu and Zn. From the shape of the spectra the level density for these elements was found, for excitation energies E^* in the region 4—11 MeV, to be proportional to $\exp(E^*/T)$ with $T =$ = constant, rather than to $\exp\sqrt{aE^*}$. This does not agree with the simple Fermi gas theory, but is consistent with recent theories taking into account the fact that the nucleons at low excitation energies cannot be regarded as free Fermi gas particles. The cross-section for evaporated α-particles was found to be almost the same at the three angles in high contrast to the single peaks due to direct interactions. Using the experimentally determined level density functions, the cross-sections for (α,α') compound nucleus scatterings were calculated by means of the statistical theory. The calculated cross-sections agree with the measured values within a factor of two.

539.17

7350. $H^3(\alpha,\gamma)Li^7$ AND $He^3(\alpha,\gamma)Be^7$ REACTIONS.
H.D.Holmgren and R.L.Johnston.
Phys. Rev., Vol. 113, No. 6, 1556-9 (March 15, 1959).

Cross-sections for these reactions were measured at bombarding energies of 480, 720, 940, 1130, and 1320 keV. The cross-sections at the lower bombarding energies may be fitted within the experimental uncertainties by the expressions

$$\sigma = 0.12(1-0.000\,51E_\alpha)E_\alpha^{-1}\exp(-125E_\alpha^{-1/2})\,b$$

for the H^3 reaction and

$$\sigma = 2.8(1-0.000\,55E_\alpha)E_\alpha^{-1}\exp(-250E_\alpha^{-1/2})\,b$$

for the He^3 reaction, with E_α in keV.

539.17

7351. EXCITATION FUNCTIONS OF BISMUTH AND LEAD.
W.J.Ramler, J.Wing, D.J.Henderson and J.R.Huizenga.
Phys. Rev., Vol. 114, No. 1, 154-62 (April 1, 1959).

Cross-sections for the reactions $Bi^{209}(He^4,2n)At^{211}$, $Bi^{209}(He^4,3n)At^{210}$, and $Bi^{209}(He^4,4n)At^{209}$ were measured with helium ions of energies from 20.6 to 43.3 MeV. Cross-sections for the reactions $Bi^{209}(d,p)RaE$, $Bi^{209}(d,n)Po^{210}$, $Bi^{209}(d,2n)Po^{209}$, $Bi^{209}(d,3n)Po^{208}$, and $Pb^{208}(d,p)Pb^{209}$ were measured with deuterons of energies from 6.3 to 21.5 MeV. Some information is presented on the $Bi^{209}(He^4,t)Po^{210}$ reaction. A half-life of 7.23 ± 0.04 hr was measured for At^{211}. The $Bi^{209}(d,3n)Po^{208}$ threshold energy is 12.0 ± 0.3 MeV (centre-of-mass system). The compound nucleus reaction cross-sections are compared with the predictions of the Jackson model, and good agreement is obtained. The (d,n) and (d,p) stripping cross-sections are discussed briefly.

539.17

7352. EXCITATION FUNCTIONS OF U^{235} AND U^{238} BOMBARDED WITH HELIUM AND DEUTERIUM IONS.
J.Wing, W.J.Ramler, A.L.Harkness and J.R.Huizenga.
Phys. Rev., Vol. 114, No. 1, 163-73 (April 1, 1959).

Cross-sections were determined for the reactions $U^{238}(He^4,n)Pu^{2}$ [including $U^{238}(He^4,p)Np^{241} - \beta^- \rightarrow Pu^{241}$], $U^{238}(He^4,2n)Pu^{240}$, $U^{238}(He^4,3n)Pu^{239}$, $U^{238}(He^4,4n)Pu^{238}$, $U^{238}(He^4$, fission), $U^{235}(He^4,n)Pu^{2}$ and $U^{235}(He^4,3n)Pu^{236}$ induced by helium ions of energies from 18.0 t 43.0 MeV. The yields of Pu^{239}, Pu^{240}, and Pu^{241} were determined by a mass spectrometric technique. Cross-sections were measured for the reactions $U^{238}(d,p)U^{239}$, $U^{238}(d,2n)Np^{238}$, $U^{238}(d,4n)Np^{236}$(22 hr) $U^{238}(d,t;\ d,p2n)U^{237}$, $U^{235}(d,n)Np^{236}$(22 hr), $U^{235}(d,2n)Np^{235}$, and $U^{235}(d,3n)Np^{234}$ induced by deuterons of energies from 5.8 to 21.5 Me The above excitation functions are compared with similar excitatio functions of nonfissile nuclei to show the effect of fissionability on spallation cross-sections. Mean values of Γ_n/Γ_f are derived for several heavy nuclides by fitting the experimental excitation functio with theoretical cross-sections calculated from the Jackson model modified for fission. In addition to the discussion on the compound-nucleus formation mechanism, some discussion of the experimental evidence for direct interactions is given.

539.1

7353. RADIATIVE ALPHA-PARTICLE CAPTURE IN Ni^{58} AND Xe^{136} AT HIGHER ENERGIES. J.B.Ball, A.W.Fairhall and I.Halpe
Phys. Rev., Vol. 114, No. 1, 305-9 (April 1, 1959).

The cross-sections of the (α,γ) reaction were measured as a function of bombarding energy in Ni^{58} and Xe^{136} up to about 35 MeV

In both cases the capture events were identified by means of the specific radioactivity produced in the reaction. In the bombardment of Ni^{58} it was necessary to make use of the tight angular spread of recoils in the capture reaction to distinguish these recoils from those of the Ni^{60}(α,2n) reaction. Both measured capture cross-sections rise to a maximum value (Ni^{58} : 400 μb, Xe^{136} : 60 μb) at an excitation energy of about 20 MeV. A comparison of the observed cross-sections with those obtained in (p,γ) reactions at similar energies suggests that these higher energy capture reactions take place largely through the formation of a compound nucleus rather than by any "direct" mechanism.

539.17

7354. ANGULAR DISTRIBUTIONS AND CORRELATIONS FOR ALPHA-PARTICLE SCATTERING BY C^{12}, Mg^{24}, AND Ca^{40}.

G.B.Shook.

Phys. Rev., Vol. 114, No. 1, 310-21 (April 1, 1959).

Angular distributions of alpha-particles scattered from Mg^{24} and Ca^{40} are reported and effective interaction radii are obtained, based on the Born approximation for elastic scattering and direct-interaction theory for inelastic scattering. For Mg^{24}, levels at 0, 1.37, 4.2, and 6.3 MeV yield interaction radii of 6.4, 6.55, 6.5, and 6.5, respectively (units of 10^{-13} cm). Evidence is presented in support of the assignment of the 6.3 MeV level to Mg^{24} rather than to Mg^{25} or Mg^{26}, with spin and parity 1−. For Ca^{40}, level at 0 and 4.48 MeV yield interaction radii of 6.65 and 7.3, respectively. Alpha—gamma angular correlations, which correspond closely to those predicted on the basis of direct-interaction theory, were obtained for C^{12} (4.43 MeV level) and for Mg^{24} (1.37 MeV level). For Ca^{40} (4.48 MeV level) the correlation corresponds qualitatively to that predicted for a 1− level with cascade decay through an intermediate state to ground level. Further evidence is presented which supports this interpretation. A higher level in Ca^{40} is observed at 8.4 MeV. All alpha bombardments were made at 43 MeV incident energy.

539.17

7355. LIGHT-PARTICLE SPECTRA FROM THE NITROGEN BOMBARDMENT OF OXYGEN.

M.L.Halbert and A.Zucker.

Phys. Rev., Vol. 114, No. 1, 132-6 (April 1, 1959).

Energy spectra and angular distributions were measured for protons and α-particles resulting from the nitrogen bombardment of oxygen. It was found that the angular distributions of protons are reasonably isotropic whereas α-particles are peaked in the forward direction. The energy distributions at various angles were compared with the predictions of a simple level density formula $w = C \exp[2(aE^*)^{1/2}]$. The constant a was found to be a = 2.5 ± 0.2 from proton spectra, a = 1.3 ± 0.2 from α-particle spectra at all angles measured. The energy spectrum of deuterons was measured at 15° and a value of a = 1.8 ± 0.3 was found. Unexplained structure was observed in the spectrum of α-particles emitted at zero degrees. After correction for the phase space available and the barrier penetration, it was found that α-particles are emitted on the order of ten times more copiously than protons, while deuterons are about half as abundant as protons.

539.17

7356. NUCLEON CORRELATION EFFECTS IN HIGH ENERGY ELECTRON SCATTERING.

R.Gatto.

Nuovo Cimento, Vol. 12, No. 1, 70-83 (April 1, 1959).

A detailed investigation is carried out of the role of nucleon—nucleon correlations in the inelastic scattering of high energy electrons by nuclei summed over all nuclear excitations. It is concluded that the dominant correlation effect is that caused by the exclusion principle and the differential cross-section can be rather accurately predicted independently of the details of the nuclear dynamics.

539.17

7357. A REMARK ON THE INTERPRETATION OF THE ELECTRON—NUCLEUS SCATTERING EXPERIMENTS.

C.Villi.

Nuclear Phys., Vol. 10, No. 2, 166-80 (Feb. (2), 1959).

The consequences on the interpretation of the data, arising from the finite size of the proton or of the electron, or of both, are discussed.

539.17 : 539.14

7358. HIGH-ENERGY ELECTRON SCATTERING FROM LITHIUM-6.

G.R.Burleson and R.Hofstadter.

Phys. Rev., Vol. 112, No. 4, 1282-6 (Nov. 15, 1958).

The Li^{6} nucleus was studied at 426 MeV by electron scattering methods between laboratory angles of 33° and 57.5°. Absolute values of the Li^{6} cross-sections were obtained by comparison with scattering measurements made on the proton at 426 MeV and 40°. Unique values of the experimental form factors are given in tabular form. The results are analysed in terms of various possible charge distributions. Several examples of models showing a good fit are presented and appropriate radius and skin thickness values are given. Several unsuccessful models are also discussed.

539.17

7359. THE (γ,p) REACTION ON INDIUM.

M.Rozkoš.

Czech. J. Phys., Vol. 7, No. 1, 20-5 (1957). In Russian.

Gamma quanta of energies 17.6 MeV and 14.8 MeV impinged on an indium target and the resulting photo-protons were recorded in Agfa K2 nuclear emulsion plates placed at various angles to the target and the incident beam. Examination of the proton tracks enabled the energies to be determined, and angular and energy distributions were constructed. By comparing these with theoretically predicted distributions it was established that most of the protons were produced by evaporation and only about three per cent by direct photonuclear effect. From the energy distribution it was also possible to determine the following beta energy levels of the Cd^{114} nucleus: 3.8, 4.9, 5.6, 6.7 and 7.6 MeV. J.W.Gardner

539.17

7360. ELASTIC SCATTERING OF 1.6 MeV GAMMA RAYS FROM H, Li, C, AND Al NUCLEI.

L.W.Alvarez, F.S.Crawford, Jr and M.L.Stevenson.

Phys. Rev., Vol. 112, No. 4, 1267-73 (Nov. 15, 1958).

Measured at an angle of 124°. The ratios of the measured differential cross-sections to the classical Thomson differential cross-sections are 0.94 ± 0.16 for H, 0.92 ± 0.10 for Li, 1.06 ± 0.10 for C, and 1.15 ± 0.10 for Al. These results agree with the field-theory prediction that in the low photon-energy limit the cross-section must approach the classical Thomson cross-section.

539.17

7361. NUCLEAR RAMAN EFFECT.

Z.Marić and P.Möbius.

Nuclear Phys., Vol. 10, No. 2, 135-9 (Feb. (2), 1959).

The dependence of the photo-effect on nuclear orientation is discussed. The cross-section for the excitation of rotational states in non-elastic γ-scattering by deformed nuclei is computed.

539.17

7362. GAMMA-RAY EXCITATION OF THE 15.1 MeV LEVEL IN C^{12}.

E.L.Garwin.

Phys. Rev., Vol. 114, No. 1, 143-54 (April 1, 1959).

The parameters of the 15.1 MeV level in C^{12} were determined. The angular distribution of scattered photons was determined to be dipole. A scatterer-associated background to the scattering from this level has been demonstrated. The peak absorption cross-section of 29.7 ± 1.1 barns was determined from a self-absorption experiment. The self-absorption measurement and a production experiment combine to give values of 64.5 ± 10.4 and 59.2 ± 9.7 eV for the total level width and radiative width to the ground state, respectively. The combination of the value of the integrated elastic scattering cross-section from the absolute measurement, and those values calculated from the self-absorption and production experiments gives for this integrated cross-section the value 2.33 ± 0.19 mb-MeV. The radiation width to the 4.43 MeV state of C^{12} is determined to be 3.2 ± 2.5 eV by fitting the detector resolution function to observed pulse-height spectra. A value for the inelastic scattering in the giant resonance region of C^{12} is determined.

539.17

7363. THE REACTION K^{40}(n$_{th}$, p)A^{40}.

J.Rossel and J.Weber.

Helv. phys. Acta, Vol. 31, No. 7, 727-33 (1958). In French.

The protons emitted by a thin layer of enriched KCl under irradiation with monoenergetic neutrons of 0.054 eV were recorded in Ilford C$_2$ nuclear emulsion. The total neutron flux was monitored by the N^{14}(n, p)C^{14} reaction observed in the same emulsion. The cross-section for K^{40} was found to be σ(n, p) = (3.8 ± 0.7) × 10^{-24} cm^2, and the energy of the proton E$_p$ = (2.23 ± 0.10) MeV in good agreement with the value deduced from the masses. Using the experimental value of σ(n, p)/σ(n, γ), a reasonable guess for Γ_γ and the theoretical estimate of Γ_p, it appears probable that the involved level of the compound nucleus K^{41} has spin J = 9/2 and odd parity.

539.17

7364. NEUTRON SCATTERING AT 2.2 MeV BY TIME OF FLIGHT.

H.H.Landon, A.J.Elwyn, G.N.Glasoe and S.Oleksa.

Phys. Rev., Vol. 112, No. 4, 1192-200 (Nov. 15, 1958).

A millimicrosecond time-of-flight technique was applied to a study of the scattering of 2.2 MeV neutrons from targets of Fe, Pb^{206}, and Y. The 3 MeV phase-focused proton beam from the B.N.L. 18 in. cyclotron was used to produce high-intensity neutron pulses in the $T(p,n)He^3$ reaction. The angular distributions of the elastically scattered neutrons were measured for the above targets. The angular distributions of the inelastically scattered neutrons from the 0.845 MeV level in Fe^{56} and from the 0.803 MeV level in Pb^{206} were carefully studied, and were found to be symmetric about $\theta_{c.m.} = 90^0$. The angular distributions of the inelastically scattered neutrons from levels at 1.34 and 1.43 MeV in Pb^{206} and from levels at 0.913 and 1.53 MeV in Y were measured, and also appear to be symmetric about $\theta_{c.m.} = 90^0$. The inelastic scattering from Pb^{206} shows evidence for a new level at 1.15 MeV.

539.17

7365. DIFFERENTIAL ELASTIC SCATTERING OF NEUTRONS FROM NEON. H.O.Cohn and J.L.Fowler.
Phys. Rev., Vol. 114, No. 1, 194-200 (April 1, 1959).

Neutron elastic scattering from neon of natural abundance has been investigated in the energy range 0.8 to 1.9 MeV. The total cross-section was measured by the standard method of attenuating a neutron beam by a sample, which in this case was neon gas contained in a metre-long steel cylinder at high pressure. Differential cross-sections were observed both by measuring neon recoil energies in a proportional counter and also by detecting neutrons with an anthracene crystal in coincidence with neon recoils. The combination of techniques shows up resonances at the following energies (in MeV) with spin and parity assignments given in parentheses: 0.91 ($\frac{3}{2}$ −); 1.28 ($\frac{3}{2}$ −); 1.31 ($\frac{1}{2}$ −); 1.37 ($\frac{3}{2}$ or $\frac{5}{2}$ +); 1.62 ($\frac{3}{2}$ −); 1.68 ($\frac{3}{2}$ +); and 1.85 (· · ·). These resonances have reduced widths of the order of 1% of the Wigner limits.

539.17

7366. STUDY OF THE-NEUTRON REACTIONS $Li^6(n,\alpha)H^3$, $F^{19}(n,\gamma)F^{20}$, AND $I^{127}(n,\gamma)I^{128}$.
F.Gabbard, R.H.Davis and T.W.Bonner.
Phys. Rev., Vol. 114, No. 1, 201-8 (April 1, 1959).

These reactions were studied using scintillating crystals both as targets and as detectors. The neutrons were produced by the $Li^7(p,n)Be^7$ and $T^3(p,n)He^3$ reactions. A redetermination of the $Li^7(p,n)Be^7$ differential cross-section was made in the proton energy range 1.9 to 3.0 MeV at 0^0 and the cross-section observed at 2.27 MeV was 154 mb. Cross-sections for this reaction were determined at 120^0 for proton energies below 2.4 MeV and at 60^0 for energies below 2.1 MeV. The $Li^6(n,\alpha)H^3$ reaction cross-section was studied for neutron energies between 0.025 and 4 MeV. The resonance at 0.255 MeV was observed to have a width (lab) of 0.125 MeV and a maximum cross-section of 2.80 barns. A fit of the dispersion theory to this resonance yielded the following parameters in the centre-of-mass coordinates: $\gamma_n{}^2 = 0.41$ MeV cm, $\gamma_\alpha{}^2 = 0.015$ MeV cm, $\Delta_\lambda = 0.17$ MeV, $E_\lambda = 0.039$ MeV, and $\Gamma = 0.188$ MeV at the resonant energy. Sixteen resonances were observed in the $F^{19}(n,\gamma)F^{20}$ reaction at neutron energies of 0.027, 0.048, 0.100, 0.177, 0.270, 0.308, 0.388, 0.425, 0.500, 0.600, 0.760, 0.865, 0.950, 1.125, 1.290, and 1.635 MeV. The radiative widths Γ_γ of twelve of these resonances vary between 1.1 and 8.6 eV. A monotonically decreasing cross-section was observed for the $I^{127}(n,\gamma)I^{128}$ reaction between 0.025 and 0.500 MeV.

539.17 : 539.1.07

EXPERIMENTAL METHODS FOR THE STUDY OF NEUTRON CAPTURE GAMMA RAYS. See Abstr. 7221

539.17 : 539.12

7367. μ^--CAPTURE IN LIGHT NUCLEI.
E.G.Beltrametti and L.A.Radicati.
Nuovo Cimento, Vol. 11, No. 6, 793-9 (March 16, 1959).

A shell model analysis of the μ^--capture by light nuclei without heavy particle emission, is given. Some experiments are suggested to measure the coupling constant and the relative contribution of the Gamow—Teller and Fermi interactions. A detailed study is presented of the μ^--capture in He^3, Li^6 and O^{16}.

539.17

NUCLEAR REACTIONS DUE TO COSMIC RAYS. See also the Section entitled "COSMIC RAYS".

539.17 : 537.531

7368. K-SHELL X-RAYS FROM FISSION FRAGMENTS AND THEIR FISSION-FRAGMENT/CHARGE DISTRIBUTION.
V.V.Sklyarevskii, E.P.Stepanov and B.A.Medvedev.
Zh. eksper. teor. Fiz., Vol. 36, No. 1, 326-8 (1959). In Russian.

Measurements of the intensity of K-shell X-rays from a number of U^{235} fission fragments are reported. For both photo-fission and neutron-included fission fragmentsthe significant intensities come from the 16 keV and 31 keV X-rays. The mean number of X-quanta emitted per captured neutron is found to vary with fission fragment charge number and appears to have a minimum around Gd^{64} or Dy^{66}.
J.W.Gardner

539.17 : 539.18

7369. ON A THEORY OF NUCLEAR FUSION REACTION IN LOW TEMPERATURE. I. H.Narumi and S.Matsuo.
Doshisha Engng Rev., Vol. 9, No. 1, 1-11 (June, 1958).

Catalytic nuclear fusion reactions by μ-mesons were analysed and the general theory of non-adiabatic corrections in the bound states of a μ-mesic p—d molecular ion was developed. The calculated values are compared with the results obtained by other methods.

539.17 : 539.18

7370. ON A THEORY OF NUCLEAR FUSION REACTIONS IN LOW TEMPERATURE. II. H.Narumi and S.Matsuo.
Doshisha Engng Rev., Vol. 9, No. 4, 143-55 (Feb., 1959).

Internal conversion processes (concerning the so-called "dead-end" processes) of the μ-mesic He^3 atom were analysed with reference to the μ-meson, and the finite-size effect of the He^3 nucleus and the irregular solutions outside this nucleus were considered. The theoretical results obtained agree reasonably well with the experimental results of experiments of Ashmore et al.(Abstr. 1270/1958) and Alvarez et al.(Abstr. 5651/1957).

539.17

7371. FUSION OF HEAVY HYDROGEN. T.E.Allibone.
Nature (London), Vol. 183, 569-73 (Feb. 28, 1959).

Substance of a discourse surveying work on controlled thermonuclear reactions, delivered at the Royal Institution on 12th Dec., 1958.
R.S.Pease

539.17 : 535.33

ROLE OF SPECTROSCOPY IN THERMONUCLEAR RESEARCH. See Abstr. 6697

539.17 : 536.2

7372. SPECIFIC PROBLEMS OF REACTOR COOLING. H.Benzler.
Atomkernenergie, Vol. 2, No. 8-9, 307-10 (Aug.-Sept., 1957). In German.

The following problems are examined: cooling channels with parallel walls and no heat generated in the channels; the cooling efficiency of channels with αu = const. (α = heat transfer coefficient; u = channel circumference), the heat source distribution function f(z) having exponential sine and unsymmetrical-sine forms; channels having constant wall temperatures. In the latter case, f(z), pressure gradients and channel profile are found.
D.H.Lord

539.17 : 536.2

7373. THE CALCULATION OF THE COOLING EFFICIENCY OF REACTOR COOLING CHANNELS. H.Benzler.
Atomkernenergie, Vol. 3, No. 3, 94-6 (March, 1958). In German.

Using the theory developed in the preceding abstract, the cooling efficiencies are calculated for the Packmann and Cutts' form for the heat source distribution $f(\zeta)$ and $f(\zeta) = a + b\zeta$. These efficiencies are then compared with those for the sine and exponential forms of $f(\zeta)$.
D.H.Lord

539.17 : 536.2

7374. SUPPLEMENT TO THE CALCULATION OF THE COOLING EFFICIENCY OF REACTOR COOLING CHANNELS. H.Benzler.
Atomkernenergie, Vol. 4, No. 2, 12-13 (Jan., 1959). In German.

The cooling efficiency of a channel in a reactor is calculated for three cases where the maximum temperature of the fuel is: (1) at the channel inlet, (2) at the channel exit, (3) somewhere between these two extremes.
D.H.Lord

539.17

7375. THE CONTROL OF NUCLEAR REACTORS. R.Vestergaar
Atomkernenergie, Vol. 2, No. 11-12, 445-51 (Nov.-Dec., 1957). In German.

The reactor is considered first as a thermal energy source. The kinetic properties of a reactor and the regulation of the reactivity are then discussed in detail, followed by a section on the principles involved and the methods used in the control of reactors.
H.C.Cole

539.17

7376. ON THE PROBLEM OF CALCULATING A REACTOR WITH A REFLECTOR ON THE BASIS OF FERMI AGE THEORY.

G.Locke.

Atomkernenergie, Vol. 2, No. 11-12, 467-75 (Nov.-Dec., 1957). In German.

The diffusion equation for thermal neutrons in a spherical reactor with an infinite reflector is solved by the standard Wiener—Hopf method. This leads to the expression of the slowing-down of fast neutrons in terms of Fermi age-theory, using a Gaussian integral kernel, and a relatively simple expression for the critical radius is thereby obtained. Comparison is made with the results of one-group and two-group theories for the case of a natural uranium, graphite-moderated reactor, and it is concluded that for most practical purposes the critical dimensions predicted by two-group theory differ insignificantly from the predictions of age theory. J.W.Gardner

539.17

7377. ON THE TRANSPORT THEORY TREATMENT OF SMALL CRITICAL RESEARCH SET-UPS. II.

K.O.Thielheim.

Atomkernenergie, Vol. 3, No. 1, 2-5 (Jan., 1958). In German.

A multi-group transport theory is developed and applied to cores in the form of spheres and plates to find their critical radii and dependence of neutron flux on position and energy. The neutron groups are defined by the number of inelastic collisions they have had; the energy distribution of neutrons inelastically scattered at U^{235} nucleii is calculated assuming the nucleii are a highly degenerate Fermi—Dirac gas. The critical radii of spheres of various enrichments are computed and found to be in agreement with those of existing research reactors. D.H.Lord

539.17

7378. ON THE TIME BEHAVIOUR OF BOILING WATER REACTORS.

A.Kirchenmayer.

Atomkernenergie, Vol. 3, No. 1, 6-10 (Jan., 1958). In German.

The efficiency and stability of the reactors is discussed in detail. Approximations are obtained for relative neutron flux and heat transfer variations for small output variations. H.C.Cole

539.17

7379. CONCERNING THE PROBLEM OF DEGENERACY INVOLVED IN THE CONCEPT OF NEUTRON PRODUCTION.

P.S.Pütter.

Atomkernenergie, Vol. 3, No. 1, 11-15 (Jan., 1958). In German.

Starting with the concept of two separate, physically meaningful, definitions of neutron production, the conversion and breeding factors are calculated for the case of a reactor undergoing epithermal fission. It is shown that these quantities differ according to the definition used, provided that the reactor is above or below the critical point. For a reactor just critical, the formulae deduced are independent of the initial definitions. Reasons for this degeneracy are suggested. S.J.St-Lorant

539.17

7380. FINE STRUCTURE OF THE FLUX IN GAS-COOLED REACTOR CELLS.

G.Riesch.

Atomkernenergie, Vol. 3, No. 1, 16-21 (Jan., 1958). In German.

The solution of the diffusion equations is simplified by the assumption that the flux distribution in a cylindrical moderator is independent of the angle. An example with six uranium oxide rods is calculated. The thermal utilization factor is worked out and the formula includes a correction coefficient taking account of the fine structure in an approximate way. The paper is an extension of work by Newmarch (Abstr. 9935/1955). H.Motz

539.17

7381. TEMPERATURE AND STRESS DISTRIBUTION IN A CYLINDRICAL UNSHEATHED FUEL ELEMENT.

W.Hage.

Atomkernenergie, Vol. 3, No. 2, 49-53 (Feb., 1958). In German.

Calculations made for values of $kR < 1$ (where k is the reciprocal diffusion length and R is the radius of the fuel element) are sufficiently accurate assuming an average heat generation distribution. For values of $kR > 1$, the error is greater than 4%; this simplification, however, gives results which err on the safe side. For values of $kR > 3$, answers are obtained which are 20-40% high compared with the real values; hence under these conditions the heat generation distribution should be considered in relation to the thermal neutron flux. H.C.Cole

539.17

7382. EXAMINATION OF THE POSSIBILITY OF LOCALLY SUBSTANTIALLY INCREASING THE NEUTRON FLUX IN A REACTOR.

G.Locke.

Atomkernenergie, Vol. 3, No. 3, 89-94 (March, 1958). In German.

For the irradiation of probes, it is convenient to have in the reactor a chamber with a high neutron flux. Such a chamber would be constructed with walls of fissionable material (e.g. U^{235}, Pu^{239}) surrounded by a layer of absorber to suppress any elevation of the thermal neutron flux in the neighbourhood of the chamber. Such chambers are qualitatively examined in plane and spherical geometries, using single-group theory, to find such things as their minimum dimensions. D.H.Lord

539.17

7383. INVESTIGATIONS ON THE POSSIBLE DEVIATION OF THERMAL NEUTRON CURRENTS.

H.Völcker.

Atomkernenergie, Vol. 3, No. 10, 389-94 (Oct., 1958). In German.

The dependence of the reflective power on the reflector thickness is investigated for double and single reflector layers with plane and curved surfaces. To enable the optimal radii of curvature to be chosen for a reflector, the penetration of the neutrons is examined as a function of geometry. The neutron flux and currents are determined at various locations inside a vertical hollow column of reflecting material, with various flux conditions at its base. D.H.Lord

539.17

7384. ON A GAS-COOLED NUCLEAR REACTOR OF HIGH THERMAL EFFICIENCY.

F.Winterberg.

Atomkernenergie, Vol. 4, No. 1, 2-6 (Jan., 1959). In German.

It is possible to increase the thermal efficiency of a closed-loop gas-cooled reactor and turbines by about 10%, by allowing the gas to expand isothermally in the cooling channels of the reactor. Further improvement of the efficiency can be obtained by maintaining the fuel temperature constant. The cooling channel cross-section, the gas streaming velocity and heat source distribution are calculated to give the above conditions. D.H.Lord

539.17

7385. THE PYROMETRIC CALCULATION OF GAS-COOLED REACTORS.

H.D.Baehr.

Atomkernenergie, Vol. 4, No. 1, 7-11 (Jan., 1959). In German.

The equations connecting the power, gas temperatures, pressure-drop and pumping power are established for a single cooling channel with various types of cooling fin on the fuel element. It is then shown how these equations can be displayed as a set of "channel characteristics". These can be used to examine the gas distribution in cooling systems. D.H.Lord

539.17

7386. THE PYROMETRIC CALCULATION OF GAS-COOLED REACTORS.

H.D.Baehr.

Atomkernenergie, Vol. 4, No. 2, 49-55 (Feb., 1959). In German.

It is shown how the use of the "channel characteristics" enable the optimum pumping power and minimum cost of output power, to be picked. For a special coolant distribution, this is carried out analytically. The techniques described in this and the preceding paper are illustrated by calculations on a high-pressure gas-cooled reactor, with three zones of constant diameter cooling channels. D.H.Lord

539.17 : 536.2

7387. HEAT LOAD IN REACTORS.

M.Ledinegg.

Atomkernenergie, Vol. 4, No. 1, 14-22 (Jan., 1959). In German.

A relation connecting the optimum thermal rate, the highest permissible fuel temperature, the reactor dimensions and the minimum work to be done by circulating pumps is established for reactors with various cooling fluids (e.g. H_2O, CO_2, liquid metals). The possibility of reducing pumping effort by varying the cooling channel cross-sections is examined. D.H.Lord

539.17

7388. NEUTRON FLUX WITHIN CYLINDRICAL AIR GAPS.

S.P.Levy de Bollini and C.G.Bollini.

J. nuclear Energy, Vol. 5, No. 1, 33-40 (1957).

A method is used which allows the calculation of the neutron-flux distribution at the interior of air gaps of any geometry. From the values of the vectorial flux at the surface, and from the form of this surface, the neutron flux at any interior point of the gap can be evaluated. The diffusion theory gives the values of the flux and its normal derivative at any point of the surface. These values are all one needs for the determination of the vectorial flux (in this approximation). In the case of two concentric infinite cylinders (the interior one being a black rod), the flux shows a maximum inside the gap. The physical significance of this effect is explained.

539.17

7389. NEUTRON FLUX DISTRIBUTION IN AN AXIALLY FINITE ANNULAR GAP SURROUNDING A BLACK ROD. J.M.Døderlein.

JENER Rep., No. 56, 6 pp. (1958).

The effect of the assumption of an axially infinite rod and annular gap on the neutron flux distribution calculated by Bollini (see preceding abstract) is examined both theoretically and experimentally. The assumption is still made of a diffusion-type angular flux distribution at the gap surface. Agreement between experiment and theory is good, and the conclusion is reached that, for the axial length of the system greater than twice the outer diameter of the annulus, the gap may be considered infinite to a good approximation. Curves of results are presented. T.O.Jeffries

539.17

7390. PILE OSCILLATOR MEASUREMENTS OF ETA.

C.O.Muehlhause.

Nuclear Sci. Engng, Vol. 5, No. 4, 225-6 (April, 1959).

Values for the number of neutrons produced per thermal neutron absorbed, η_{th}, in the three fissile materials U^{233}, U^{235}, and Pu^{239} are reported. The measurement of these quantities was performed between 1951 and 1953 at the Argonne National Laboratory using the original enriched heavy water reactor, CP3[1], and the technique of pile oscillation. A slight revision of the data has been made on the basis of new total cross-sections and f-values. The eta values at thermal energy (0.0253 eV) were found to be $\eta_{23} = 2.25 \pm 0.03$, $\eta_{25} = 2.05 \pm 0.03$, and $\eta_{49} = 2.04 \pm 0.04$.

539.17

7391. RESONANCE ESCAPE PROBABILITY IN WATER LATTICE.

H.Takahashi.

Nuclear Sci. Engng, Vol. 5, No. 4, 237-41 (April, 1959).

In light water-moderated reactors the effects of adjacent fuel on resonance escape probability must be considered. These effects are a decrease of surface absorption and modification of the slowing down density by absorption. Modifications of the standard formula for calculating p are described and the results of detailed calculations on enriched uranium dioxide fuel rods in water lattices are given. The effective resonance integral is calculated by the method of Wigner et al.

539.17

7392. ON THE VALIDITY OF THE SECOND FUNDAMENTAL THEOREM FOR SMALL REACTORS. E.Inönü.

Nuclear Sci. Engng, Vol. 5, No. 4, 248-53 (April, 1959).

The second fundamental theorem of reactor theory gives a general expression for the non-escape probability. To check the validity of this expression for small sizes, first-flight nonescape probabilities are calculated for neutrons which have originated from either a persisting or a uniform stationary distribution in slabs of half-widths ranging from 0.1 to 10 mean free paths. Exact values computed directly from the integral formulation are compared with the approximate values obtained by expanding the distributions in eigen solutions of the wave equation and applying the general theorem, assuming that the linear extrapolation of the final flux vanishes on the extrapolation surface. It is found that the non-escape probabilities given by the fundamental theorem remain quite accurate even when the size of the reactor is decreased to the order of the mean free path. For a slab which is only two mean free paths wide, the fractional difference from the exact value is 1.5% for the persisting distribution and 2.5% for the uniform distribution.

539.17

7393. THE DYNAMIC REACTIVITY INTERPRETATION OF PULSED NEUTRON MEASUREMENTS. B.E.Simmons.

Nuclear Sci. Engng, Vol. 5, No. 4, 254-6 (April, 1959).

A dynamic reactivity, not the reactivity in general use, is defined relative to prompt critical as $\Delta K = -l\alpha$, where α is the asymptotic (prompt) flux decay rate observed in a pulsed neutron experiment, and l is the prompt generation time of that same reactor made prompt critical by uniform subtraction of 1/v poison. The dynamic reactivity coalesces near critical with the conventional perturbation reactivity $\delta\nu/\nu$. The dynamic reactivity is physically interpretable as the amount of uniform 1/v poison whose removal would result in criticality, times the conventional reactivity coefficient of that poison in the critical reactor. The quantity l has the physical significance of the average time taken by a neutron to cause a fission in the steady-state prompt-critical reactor; l is also the reactivity coefficient just mentioned.

ATOMS

539.1

7394. ATOMIC ELECTRON AFFINITIES.

H.R.Johnson and R.Rohrlich.

Nature (London), Vol. 183, 244-5 (Jan. 24, 1959).

Increased accuracy in measurement of electron affinities of negative atomic ions makes it desirable to improve on the semi-empirical method of Glockler [Phys. Rev., Vol. 46, 111 (1934)] which yields values in error by 0.3-0.5 eV. A new extrapolation formula is given, for which physical justification is claimed, involving two parameters which may be checked by independent methods. R.C.Seymour

539.18 : 537.521

ATOMS TRAPPED AT 4.2°K FROM GASEOUS DISCHARGE. See Abstr. 7016

539.18

7395. SOLUTION OF THE FERMI–THOMAS EQUATION FOR POSITIVE IONS. H.Payne.

J. chem. Phys., Vol. 30, No. 1, 343-4 (Jan., 1959).

The solution is written as an infinite series $\varphi_o \Sigma g_n k^n (\eta_o/\varphi_o)^n$, of which the first two terms give Fermi's approximation. An approximate form for the functions g_n is proposed, and the functions needed to calculate them are tabulated. An error of less than 0.1% is claimed. J.Hawgood

539.18

7396. SUPERPOSITION OF CONFIGURATIONS AND NATURAL SPIN ORBITALS. APPLICATIONS TO THE He PROBLEM.

H.Shull and P.O.Löwdin.

J. chem. Phys., Vol. 30, No. 3, 617-26 (March, 1959).

The method of superposition of configurations is examined in its application to the helium atom in two cases: a 21 × 21 matrix including all configurations up to $\langle 6s \rangle^2$, and a 20 × 20 matrix with all configurations up to the 4 quantum level, including angular terms. A new radial limit is established at −2.879 00 ± 0.000 03, and this is used to discuss the convergence of such expansions in Legendre functions. The variation with scale factor is discussed in detail. The wave-functions are analysed in terms of natural spin orbitals (NSO's), which seem to have many advantages. The first NSO bears a striking resemblance to the Hartree—Fock function, and the first two together provide a close approximation to the solution of the extended Hartree—Fock equations with different orbitals for different electrons. An energy of −2.877 924 is obtained for the best (u, v) function found. An analysis of the results suggests that inner orbitals may be better represented by pure exponentials than by Hartree—Fock orbitals whenever additional correlational degrees of freedom are permitted. Expressed in approximate NSO form, the wave-function is almost invariant to choice of basis set, provided that the latter is reasonably chosen. In particular, the necessity of including continuum terms along with the discrete hydrogen-like set is demonstrated.

539.18

7397. ON THE THEORY OF EXPERIMENTS ON THE DEACTIVATION OF METASTABLE ATOMS IN COLLISIONS WITH ATOMS OR MOLECULES. V.A.Fabrikant.

Optika i Spektrosk., Vol. 5, No. 6, 711-12 (1958). In Russian.

Kvift and Vegard (Geofys. Publ., Vol. 17, 1, 1947) studied the 5577 A line emitted by metastable atoms of oxygen in an electric discharge. This line corresponds to the forbidden transition $^1S-^3P$. The present author questions Kvift and Vegard's treatment and derives a formula for the mean concentration of metastable atoms in the discharge tube in terms of the number of exciting collisions with electrons and the number of deactivating collisions with atoms, molecules or electrons. A.Tybulewicz

539.18 : 537.53

7398. X-RAY INCOHERENT SCATTERING FUNCTION OF ATOMS BASED ON THE THOMAS–FERMI THEORY. T.Tietz.

Phys. Rev., Vol. 113, No. 6, 1521-2 (March 15, 1959).

A simplified method is given of calculating the X-ray incohere scattering function which appears in the Thomas—Fermi theory. The values are compared with the corresponding numerical values of Bewilogua (1931).

539.18

399. CONTRIBUTION OF CORE POLARIZATION TO THE
TOMIC HYPERFINE STRUCTURE AND KNIGHT SHIFT OF Li
ND Na. M.H.Cohen, D.A.Goodings and V.Heine.

roc. Phys. Soc., Vol. 73, Pt 5, 811-17 (May, 1959).

The effect of exchange forces on the wave-functions of an atom
esulting from the unpaired spin of a single electron outside closed
hells is considered. Calculations were carried out for lithium
nd sodium starting from the usual self-consistent field wave-
inctions using a modified type of perturbation theory. These yield
n increase of 31% for Li and 5½% for Na in the value of the hyper-
ne coupling constant. In addition, the effect of this core polariza-
on on the theory of the Knight shift metals is developed in detail.

539.18 : 539.14

CHARGE DISTRIBUTION OF EXCITED ISOMERIC NUCLEI
ND ATOMIC SPECTRA (THE NUCLEAR ISOMERIC SHIFT).

ee Abstr. 7309

539.18

400. SEPARATION OF BORON ISOTOPES. III. THE N-BUTYL
JLFIDE—BF$_3$ SYSTEM. A.A.Palko.

chem. Phys., Vol. 30, No. 5, 1187-9 (May, 1959).

For Pt II, see Abstr. 719 (1959). The gas—liquid isotopic ex-
iange between BF$_3$ and the n-butyl sulphide—BF$_3$ complex was
udied as a possible system for enriching boron isotopes. The
ngle stage separation factor varied from 1.054 at −20° C to 1.033 at
° C. B^{10} concentrated in the liquid phase. The heat of association
the n-butyl sulphide-boron trifluoride complex was determined to
−12.76 ± 0.06 kcal/mole from a series of vapour pressure measure-
ents of the complex made at several mole ratios of BF$_3$ to sulphide.

539.18

401. NITROGEN ISOTOPIC FRACTIONATION BETWEEN NITRIC
CID AND THE OXIDES OF NITROGEN. L.L.Brown and G.M.Begun.

chem. Phys., Vol. 30, No. 5, 1206-9 (May, 1959).

The single-stage nitrogen isotopic separation factor between
tric acid and the oxides of nitrogen has been measured as a function
temperature and nitric acid concentration. Nitric acid molarities
ere varied from 1.084 to 15.45 and temperatures from 26 to 70° C
ere used. The separation factor was found to vary from 1.01 to 1.064,
ith nitrogen-15 concentrating in the nitric acid phase. The experi-
ental data are compared with values calculated from spectroscopic
d chemical data.

539.18

402. ON DETERMINATION OF THE ISOTOPIC COMPOSITION
ROM ABSORPTION SPECTRA.

N.Zaidel'.

ptika i Spektrosk., Vol. 4, No. 5, 701-2 (1958). In Russian.
glish summary: PB141047T-2, obtainable from Office of
chnical Services, U.S. Dept. of Commerce, Washington, D.C.,
S.A.

This is a theoretical note suggesting the use of absorption
ectra for isotopic analysis of substances placed in gas flames.
odulated light from a source containing one of the two isotopes
idied passes through the gas flame and a monochromator is used
separate out a particular line. The absorption coefficient for
line (emitted by the source) is measured. The same procedure
repeated for the second isotope. Simple relationships are obtained
the line used for measurements has no hyperfine structure and if
separation between the isotopic components is much greater than
measured line half-width. The method may be extended to an
alysis of a mixture of more than two isotopes. Experimental
sults will be published later.

539.18

03. THE SEPARATION TUBE. XVII. THE PREPARATION OF
IE RARE ISOTOPE Ne^{21} AT A PURITY OF 99.6%.

Clusius, M.Huber, H.Hürzeler and E.Schumacher.
Naturforsch., Vol. 11a, No. 9, 702-9 (1956). In German.

For Pt XVI, see Abstr. 3543 (1956). A quantity of Ne containing
.6% Ne^{21} was prepared from 60 litres of normal Ne (0.257% Ne^{21})
a five stage process in a thermal diffusion plant. The concentra-
n distribution of the three isotopes Ne^{20}, Ne^{21} and Ne^{22} in the plant
re measured and found to be in good agreement with theory. By
addition of deuterated methane (CD$_4$/CD$_3$H/CH$_2$D$_2$) as an auxiliary
s it was found possible to strip off the end isotopes of even mass
m a concentrate of 92.9% Ne^{22}, 3.95% Ne^{21}, and 3.15% Ne^{20} so that
eon of 99.6% Ne^{21} remained containing only 0.2% of Ne^{22} and Ne^{20}.
chnical data are discussed, and also the advantages of using an
xiliary gas. H.C.Cole

539.18

7404. THE SEPARATION TUBE. XVIII. PURE PREPARATIONS OF THE RARE ARGON ISOTOPES A^{36} AND A^{38}.

K.Clusius, E.Schumacher, H.Hürzeler and H.U.Hostettler.
Z. Naturforsch., Vol. 11a, No. 9, 709-15 (1956). In German.

A quantity of argon containing 14.5% A^{36} was prepared from 1000 litres of normal technical argon (0.063% A^{36}) by a three-stage process in a thermal diffusion plant. The concentration distribution in the ternary system A^{36}/A^{38}/A^{40} was measured and found to agree with separation tube theory. A further separation was achieved by the addition of a DCl/HCl mixture as an auxiliary gas yielding 99.9% A^{36}. A^{38} was also obtained at a purity of 99.6%. The concentration distribution of the three argon isotopes in the auxiliary gas mixture D^{37}Cl/D^{35}Cl/H^{37}Cl/H^{35}Cl is examined and discussed. It is shown that D^{35}Cl/D^{37}Cl as an auxiliary gas is especially favourable for the A^{38}/A^{40} separation and H^{35}Cl/D^{35}Cl for the A^{36}/A^{38} separation.
H.C.Cole

539.18

7405. THE SEPARATION TUBE. XIX. ENRICHMENT OF THE ISOTOPES Br^{79} AND Br^{81}. K.Clusius and H.U.Hostettler.

Z. Naturforsch., Vol. 12a, No. 12, 974-82 (1957). In German.

In order to separate Br^{79} and Br^{81} by the thermal-diffusion method, the separation tube was filled with HBr as filling gas. The dissociation of HBr into H$_2$ and Br$_2$ produced disturbances; these were prevented by small additions of H$_2$, much smaller than those based on thermodynamical considerations, which can be explained by properties of the system, relating to reaction kinetics (Br$_2$ recombining with H$_2$ excess). The highest so far obtained enrichment degrees are 84.5% Br^{79} and 63.8% Br^{81}. It was found that HBr as auxiliary gas was very effective in the separation of Kr isotopes.
F.Lachman

539.18

7406. THE SEPARATION TUBE. XX. COMPARISON OF THE THERMAL DIFFUSION CONSTANTS OF N^{14}N^{15}/N$_2^{14}$ AND N^{15}O/N^{14}O. THE PARADOX OF THE INFLUENCE OF TEMPERATURE IN THE SEPARATION TUBE. K.Clusius and P.Franzosini.

Z. Naturforsch., Vol. 12a, No. 8, 621-9 (1957). In German.

The separation factors of the systems N^{14}N^{15}/N$_2^{14}$ and N^{15}O/N^{14}O are compared with each other in a glass hot-wire thermal diffusion column at various temperatures and at pressures up to 2 atm. It is shown that NO offers some advantage over N$_2$. One can simultaneously obtain the heavy oxygen isotopes and at high concentrations of N^{15} the equilibrium adjustment between N$_2^{14}$, N^{14}N^{15}, and N$_2^{15}$ is avoided. The thermal diffusion factor for NO^{15}/NO^{14} at 350° K is about 80% of that for N^{14}N^{15}/N$_2^{14}$. Hence an NO plant gives about 1.5 times larger production cost than the N$_2$ plant for equal quantities of N^{15}. On increasing the temperature, the conditions for NO became relatively more favourable, the limit being set by decomposition of the gas. The paradox of the lower separating efficiency at higher wire temperatures is discussed and explained by separation tube theory.
H.C.Cole

539.18 : 533.15

A JET METHOD FOR ISOTOPE SEPARATION.

See Abstr. 6603

539.18 : 535.345.6

APPLICATION OF AN INTERFERENCE-POLARIZATION FILTER IN THE ANALYSIS OF THE ISOTOPIC COMPOSITION OF HYDROGEN—DEUTERIUM MIXTURES.

See Abstr. 6756

539.18 : 536.48

EXPERIMENTAL WORK WITH He^3.

See Abstr. 6849

539.18

7407. INELASTIC ATOMIC COLLISION PROCESSES.

E.J.Gerjuoy.

J. appl. Phys., Vol. 30, No. 1, 28-33 (Jan., 1959).

At nonrelativistic energies, for arbitrarily complicated collisions of distinguishable or indistinguishable particles, with or without rearrangement, correct formal expressions for the cross-sections are known and well established. Nonetheless, all inelastic collision cross-sections must be estimated, rather than predicted accurately, because even with present high speed computers there is no three-or-more particle collision for which it is practical to solve the Schroedinger equation exactly. The validity of the customary Born approximation, and of other more elaborate approximate calculations, are discussed, mainly with reference to electron excitation cross-sections. The evidence suggests that a "compound ion model" of excitation, which is contrasted with the more usual "direct interaction model", may prove helpful in understanding the sharp peaks and other anomalous features in some excitation cross-sections near threshold. It is argued briefly that (i) there are reasons to think that at high energies Born approximation is not valid for exchange amplitudes, which are the only amplitudes appearing in excitation involving change of spin multiplicity; (ii) there are circumstances when Born approximation becomes increasingly valid as the incident electron energy is decreased.

539.18

7408. ELASTIC AND INELASTIC SCATTERING OF LOW-VELOCITY IONS: Ne^+ IN A, A^+ IN Ne, AND A^+ IN A. W.H.Cramer.
J. chem. Phys., Vol. 30, No. 3, 641-2 (March, 1959).

Elastic and charge-exchange cross-sections were measured in the energy range 4 to 400 eV for Ne^+ in A, A^+ in Ne, and A^+ in A. Charge exchange was observed only for A^+ in A. No evidence was found for the existence of the diatomic ion NeA^+. Constants for empirical potential functions were evaluated and the functions tabulated.

539.18

7409. DESTRUCTION OF METASTABLE HELIUM ATOMS IN BINARY COLLISIONS. O.von Roos.
J. chem. Phys., Vol. 30, No. 3, 729-34 (March, 1959).

A calculation of the cross-section for the reaction $He' + He' = He + He^+ + e$ (destruction of the metastable 2^3S state by ionization) was performed by means of the perturbed stationary state method. The cross-section obtained is of the order of magnitude 10^{-18} cm^2 at room temperature and increases slowly with decreasing kinetic energy of the colliding particles. The magnitude of the cross-section fits well with a tentative scheme which considers processes of the type $A' + B = A + B^+ + e$ as being intermediate between true resonance collisions and nonresonance collisions. It disagrees by 4 orders of magnitude with experimental findings (Abstr. 4290/1953) The reason for this discrepancy is not known.

539.18

7410. CHARGE EXCHANGE IN PROTON-HYDROGEN-ATOM COLLISIONS. W.L.Fite, R.T.Brackmann and W.R.Snow.
Phys. Rev., Vol. 112, No. 4, 1161-9 (Nov. 15, 1958).

The charge-exchange cross-sections for the reactions $p + H \rightarrow H + p$, and $H_2^+ + H \rightarrow H_2 + p$ have been examined over the energy range 200 to 14 000 eV. In the experiment a d.c. fast-ion beam crossed a slow atomic hydrogen beam which was chopped at 100 c/s. The desired signal thus was separable from the much larger signal arising from interaction of the ions with the residual gas in the vacuum chamber, because the signal arising from the interaction of the two beams occurred at the chopping frequency and in a specified phase. The signals used were the saturated slow-ion currents, recorded at a detector which did not discriminate the ion mass, and the slow-ion currents after mass analysis. The measured values at high energies agree very satisfactorily with the Born approximation calculations by Bates and Dalgarno and, at low energies, with calculations by Dalgarno and Yadav using the method of perturbed stationary states. Experimental comparison of cross-sections for proton and deuteron collisions is presented.

539.18 : 539.12

THE EFFECTIVE ATOMIC FIELD FOR ELECTRON SCATTERING. See Abstr. 7247

539.18

7411. VAN DER WAALS FORCES. A.Dalgarno and A.E.Kingston.
Proc. Phys. Soc., Vol. 73, Pt 3, 455-64 (March, 1959).

Theoretical and experimental values of electric dipole oscillator strengths are used to calculate the coefficients of the leading terms in the series representations of the long range interactions between pairs of atoms. Values are obtained for pairs selected from the alkali metals, the inert gases, H, H^-, He^+ and Li^+ and are then employed to assess the accuracy of various approximate formulae. Where possible, comparison is made with experimental data and it is shown that the polarizabilities derived from molecular beam measurements are unreliable. A discussion is given of the measurements of elastic scattering of the alkali metals by the inert gases and it is concluded that the normal van der Waals interaction does not suffice to explain the observations at very low scattering angles.

539.18 : 539.17

μ-MESIC ATOMS: INTERNAL CONVERSION PROCESSES. See Abstr. 7369-70

MOLECULES

539.19

7412. MEASUREMENT OF THE RATE OF DISSOCIATION OF OXYGEN. S.R.Byron.
J. chem. Phys., Vol. 30, No. 6, 1380-92 (June, 1959).

The rate of dissociation of oxygen behind strong shock waves in pure oxygen, in mixtures of oxygen and argon, and in air was determined over a temperature range from 2800° to 5000°K. A long duration spark interferometer and drum camera were used to measure the shock speed and the variation of density behind the shock. The dissociation rate determined from the data can be represented by a collision theory equation, assuming that all of the available energy of vibration of the particles is transferred to dissociation in an inelastic collision. Oxygen atoms were found to be very effective in causing dissociation of oxygen molecules; the measured transition probability for energetically possible collisions between an oxygen atom and an oxygen molecule was 1.7, that for collisions between two oxygen molecules was 0.24. Collisions between nitrogen and oxygen molecules in air were found to be relatively ineffective in causing dissociation of oxygen; the measure rate of dissociation of oxygen in air was less than a factor of 2 larger than that caused by collisions between oxygen atoms and molecules alone.

539.1

7413. GENERAL MOLECULAR MODELS WHICH GIVE THE ARRHENIUS FORM OF FIRST-ORDER DISSOCIATION RATE. N.B.Slater.
Trans Faraday Soc., Vol. 55, Pt I, 5-8 (Jan., 1959).

It is shown that if a molecule has quantized energy and can dissociate if it has more than a critical energy, then the only molecular model giving the Arrhenius form of first-order reaction rate is that of a system of degenerate harmonic oscillators, similar to the models of Kassel. If the molecular energies are effectively classical and continuous, the Arrhenius form determines the specif rate, for molecules of given total energies, as a simple function of the classical weights of the states; and specific rates of this form arise naturally in several reaction rate theories.

539.1

7414. FORCE CONSTANTS OF THE P_4 MOLECULE. C.W.F.T.Pistorius.
J. chem. Phys., Vol. 29, No. 6, 1421-2 (Dec., 1958).

The three force constants are calculated by the F—G matrix method from published vibration frequencies. J.Hawgo

539.1

7415. BINDING ENERGY OF Ne_2^+ FROM ION SCATTERING DAT
E.A.Mason and J.T.Vanderslice.
J. chem. Phys., Vol. 30, No. 2, 599-600 (Feb., 1959).

Charge exchange and elastic scattering cross-sections for Ne^+ in Ne both indicate a fairly low binding energy of roughly 0.3 to 1.0 eV. G.I.W.Llewely

539

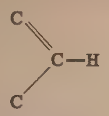
7416. FORCE CONSTANTS OF METAL HEXAFLUORIDES. H.H.Claassen.
J. chem. Phys., Vol. 30, No. 4, 968-72 (April, 1959).

Equations are given relating fundamental frequencies and force constants for a general quadratic potential function for XY_6 molecules of symmetry O_h. Tables of force constants are given hexafluorides of Mo, W, Re, Os, Ir, Pt, U, Np, and Pu.

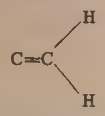
539.

7417. EFFECT OF CONJUGATION, HYPERCONJUGATION, AN STERIC HINDRANCE ON METHYL AFFINITIES. J.H.Binks and M.Szwarc.
J. chem. Phys., Vol. 30, No. 6, 1494-501 (June, 1959).

The mechanism of the addition of radicals to aromatic and ol finic compounds is discussed in terms of a potential energy diag which explains the linear relation between localization energy an the logarithm of methyl affinity per reactive centre. It is pointec out that such a linear relation is expected for series of compoun each having the same type of reaction centre, e.g.



in a series of aromatic hydrocarbons or



in a series of substrates like ethylene, styrene, butadiene, etc. The relation between the slope of such a line and the nature of the reactive centre is discussed. The foregoing treatment is extended to explain the effects caused by hyperconjugation, and an excellent agreement is found between theory and experiment. It is shown that compounds having a methyl substituent on the reactive centre are less reactive. This inhibitory action of the methyl substituent is explained in terms of steric hindrance, and it is shown that for a particular centre the inhibitory effect amounts to a constant factor independent of the original reactivity of the centre. Still greater steric effects are caused by phenyl groups and by two methyl substituents located on a reactive centre. The utility of this "blocking" technique for determining the most reactive centres is pointed out.

539.19

7418. MATRIX ELEMENTS AND EIGENFUNCTIONS OF MULTI-DIMENSIONAL OSCILLATORS BY OPERATIONAL METHODS.
I. TWO DIMENSIONAL ISOTROPIC HARMONIC OSCILLATOR.
G.A.Gallup.
J. molecular Spectrosc., Vol. 3, No. 2, 148-56 (April, 1959).

The matrix elements and eigenfunctions of a two dimensional isotropic harmonic oscillator were obtained in a representation in which the Hamiltonian function and the angular momentum are diagonal by operational methods. A theorem concerning the construction of "raising" and "lowering" operators is given.

539.19

7419. MATRIX ELEMENTS AND EIGENFUNCTIONS OF MULTI-DIMENSIONAL OSCILLATORS BY OPERATIONAL METHODS.
II. THREE DIMENSIONAL ISOTROPIC HARMONIC OSCILLATOR.
G.A.Gallup.
J. molecular Spectrosc., Vol. 3, No. 2, 157-64 (April, 1959).

The matrix elements and the first few eigenfunctions of a three dimensional isotropic harmonic oscillator was obtained in a representation in which the Hamiltonian, the total angular momentum and he z-component of the angular momentum are diagonal by combined perational and matrix method. A suggestion concerning the calcuations of general matrix elements is given.

539.19

7420. PREDISSOCIATION IN THE SCHUMANN—RUNGE BANDS OF OXYGEN.
P.K.Carroll.
Astrophys. J., Vol. 129, No. 3, 794-800 (May, 1959).

New observations of the Schumann—Runge bands of O_2 in the egion 2050-1900 A were made under high resolution. From the roadening of rotational lines a predissociation was detected in the $^3\Sigma\bar{u}$ state at low v values. The predissociation recently reported n the level v = 12 was re-investigated, and the interpretation of the ew data is discussed.

539.19

421. FREE ROTATION IN SOLIDS AT 4.2°K.
.M.McConnell.
chem. Phys., Vol. 29, No. 6, 1422 (Dec., 1958).

The author gives an alternative explanation of the nine line hyperne structure (h.f.s.) observed by Foner et al. (Abstr. 740/1959) in e ESR spectrum of NH_2 in an argon matrix at 4.2°K. It is assumed at the NH_2 radicals are freely rotating and that they have a Boltzan distribution among the rotational states corresponding to a mperature of 4.2°K. The ground state spin wave-function must then e symmetric with a total spin 1. This in addition to the h.f.s. of ^{14} would give a complete h.f.s. of nine equally intense lines as bserved.
J.M.Baker

539.19

422. TERM SERIES FOR A ROTATING-VIBRATING DIATOMIC OLECULE BY PERTURBATION.
J.E.Kilpatrick.
chem. Phys., Vol. 30, No. 3, 801-5 (March, 1959).

Expressions for the most important terms for the energy of a rotating-vibrating diatomic molecule as a function of the coefficients of its potential energy, expressed as a power series, were deduced by perturbation theory. The perturbation polynomials defined in this theory also enable one quickly and easily to calculate to a high order of accuracy the energy levels associated with any one-dimensional oscillation with a smooth, single-minimum potential.

539.19

7423. NORMAL FREQUENCIES OF THE PLANE XY_2Z MOLECULE.
C.W.F.T.Pistorius.
J. chem. Phys., Vol. 30, No. 1, 332-3 (Jan., 1959).

The elements of the Wilson F and G matrices are given for the most general harmonic force field of Abstr. 4315(1956), without assuming that the three interbond angles are equal.
J.Hawgood

539.19

7424. RELATING TORSION ANGLES TO VALENCE BOND ANGLES AND MULTIPLICITY OF THE PRINCIPAL SYMMETRY AXIS IN CYCLIC MOLECULES.
J.L.Lauer and W.H.Jones, Jr.
J. chem. Phys., Vol. 30, No. 2, 592-3 (Feb., 1959).

Theoretical. A matrix formulation enables the relations between these internal coordinates to be derived much more easily than by standard vector methods.
J.Hawgood

539.19

7425. CENTRAL FORCE FIELDS AND BENDING MOTIONS.
W.Klemperer.
J. chem. Phys., Vol. 30, No. 2, 594-5 (Feb., 1959).

Theoretical. When a coordinate is restricted to vary only over a certain interval, the first derivative of the potential energy with respect to that coordinate need not vanish at a minimum when this occurs at an end-point of the interval. This consideration invalidates the usual assumption that central forces cannot be used in the analysis of certain bending motions. The linear triatomic molecule is used as an example; the restricted coordinate is then the distance between the outer atoms.
J.Hawgood

539.19 : 535.343

7426. VIBRATIONAL INTENSITIES IN LIQUID BENZENE.
I.C.Hisatsune and E.S.Jayadevappa.
J. chem. Phys., Vol. 30, No. 3, 848 (March, 1959).

The total infrared intensities of the fundamental absorption bands of benzene at 25°C are tabulated.
G.I.W.Llewelyn

539.19

7427. COMPUTATION OF RIGID ASYMMETRIC ROTATOR CONSTANTS FROM ENERGY MOMENTS. II.
P.M.Parker and L.C.Brown.
J. chem. Phys., Vol. 30, No. 4, 909-12 (April, 1959).

For previous part see Abstr. 2610 (1958). Further expressions are given which relate the rotational constants of the rigid asymmetric rotator to experimental data through moments of the energy levels. These expressions remove the requirement that all energy levels for given J be known. Instead, the energy levels associated with one symmetry group of the rotational wave-functions for given J are required.

539.19

7428. OSCILLATION, ROTATION, AND SPIN RELAXATION IN NO.
H.J.Bauer, H.O.Kneser and E.Sittig.
J. chem. Phys., Vol. 30, No. 5, 1119-20 (May, 1959).

The sound absorption and velocity of NO gas at 293°K was measured from $f/p = 5 \times 10^4$ to 10^7 c/s per atm using an ultrasonic pulse method. A maximum of the absorption at 4×10^5 c/s per atm is ascribed to the relaxation of the oscillational degree of freedom. ($\tau_{osc} = 4 \times 10^{-7}$ sec at 1 atm). According to the absorption at high f/p values, $\tau_{spin} \cong 4\tau_{rot}$ ($=2.5 \times 10^{-9}$ sec at 1 atm) seems probable. The result is compared with the corresponding data O_2 and N_2.

539.19

7429. VIBRATION PERTURBATIONS IN ELECTRONICALLY EXCITED MOLECULES.
O.E.Weigang, Jr and W.W.Robertson.
J. chem. Phys., Vol. 30, No. 6, 1413-17 (June, 1959).

Small vibration shifts of usually 10 to 50 cm^{-1} can be observed superimposed on the electronic shifts of 200 to 1000 cm^{-1} which occur on solvation of aromatic polynuclear hydrocarbons. Vibration assignments for benzene indicate that the observed behaviour of its vibration bands is due to the perturbation of a single vibration in the electronically excited benzene molecule. The change corresponds to an increase of frequency for the excited state E_g^+ 3080 cm^{-1} C–H vibration. A similar phenomenon can be detected in the naphthalene spectrum. The results are compared to the recent work of Fishman, Benson, Wiederkehr, and Drickamer on pressure perturbations of vibrations in electronic ground state molecules in solutions.

539.19

7430. NORMAL COORDINATES FOR THE OUT-OF-PLANE DEFORMATIONS OF VINYL BROMIDE.

J.R.Scherer and W.J.Potts.
J. chem. Phys., Vol. 30, No. 6, 1527-9 (June, 1959).

A normal coordinate analysis of the out-of-plane modes of vinyl bromide shows that the description of the 943 cm^{-1} and 583 cm^{-1} modes given by Torkington is not entirely correct. The 943 cm^{-1} mode has a close resemblance to the ethylene type twist and the 583 cm^{-1} mode may be easily visualized as a wagging motion of the whole vinyl group. A comparison is also made with C_2H_3D and trans-$C_2H_2D_2$.

539.19

7431. IONIC MODELS AND THE VIBRATIONAL SPECTRA OF MOLECULES.

R.G.Pearson.
J. chem. Phys., Vol. 30, No. 6, 1537-40 (June, 1959).

It is shown that an ionic model with polarization terms gives reasonable values for the vibrational frequencies of linear symmetric MX_2 molecules. The potential function of such a model is indistinguishable from the valence force potential with interaction terms and this result is general for all molecules. Contrary to the literature, even a central force potential will give a nonzero bending frequency for a linear symmetric molecule.

539.19

7432. NORMAL COORDINATE TREATMENT AND FORCE CONSTANTS OF S_8.

C.W.F.T.Pistorius.
J. molecular Spectrosc., Vol. 3, No. 2, 101-13 (April, 1959).

The secular equations for the various irreducible representations of the S_8 molecule (point group D_{4d}) were deduced by means of Wilson's F–G matrix method, using the most general harmonic potential field. Using these equations the main force constants, as well as some interaction constants, were evaluated.

539.19

7433. THE APPLICATION OF THE COMPLETE ISOTOPIC RULE TO CERTAIN PLANE MOLECULES.

S.Brodersen and A.Langseth.
J. molecular Spectrosc., Vol. 3, No. 2, 114-22 (April, 1959).

The application of the complete isotopic rule to certain plane molecules is discussed. The treatment given does not cover all cases to which the rule may be applied, but is sufficient for most practical cases. Partly on the basis of previous results, and partly by use of new examples, the accuracy of the rule is demonstrated, and its usefulness for checking a vibrational assignment is pointed out.

539.19

7434. OPERATIONAL PROCEDURE FOR THE DETERMINATION OF THE MATRIX ELEMENTS OF THE DIRECTION COSINES FOR A RIGID SYMMETRICAL ROTATOR.

W.H.Shaffer and J.D.Louck.
J. molecular Spectrosc., Vol. 3, No. 2, 123-31 (April, 1959).

An operational procedure is presented for obtaining the matrix elements $(J'K'M'|\lambda A\alpha|JKM)$, where $\lambda A\alpha$ is the direction cosine between the A-axis ($A = X,Y,Z$) and the α-axis ($\alpha = x,y,z$) of a space-fixed XYZ reference frame and a body-fixed xyz reference frame used to describe the pure rotation of a rigid symmetrical rotator. $\Psi(J,K,M)$ are the normalized symmetrical rotator wave-functions.

539.19

7435. THE INFLUENCE OF ANHARMONICITY UPON THE VIBRATIONAL PROBABILITY DENSITIES AND MEAN AMPLITUDES IN MOLECULES. I. DIATOMIC MOLECULES.

A.Reitan.
K. Norske Vidensk. Selsk. Skr., 1958, No. 1, 20 pp. (publ. 1959).

Expressions for the vibrational probability density and root mean square deviations ("mean amplitudes") are developed by assuming three different models of the molecule: a harmonic oscillator, an anharmonic oscillator with perturbation terms of first and second order in the potential function, and an anharmonic oscillator with Morse potential. Numerical computations are performed for the hydrogen and bromine molecules.

539.19

7436. CHANGES IN TRANSITION PROBABILITY DUE TO THE INTERACTION OF ROTATION AND VIBRATION IN DIATOMIC BAND SPECTRA.

R.C.M.Learner and A.G.Gaydon.
Nature (London), Vol. 183, 242-3 (Jan. 24, 1959).

It is shown, by calculations based on wave-functions of a Morse–Pekeris oscillator, that changes in effective potential energy curves at high rotational energy may cause significant changes of vibrational transition probability. These may affect measurements of rotational temperature. An extreme example is the very weak (0,1) band of OH for which, in a flame at 2750° K, the R branches give a rotational temperature of 4180° K and the P branches only 1380° K.
A.G.Gaydon

539.19

7437. THE RULES OF AVERAGES FOR TRIATOMIC NON-LINEAR HYDRIDES AND DEUTERIDES.

V.P.Morozov.
Optika i Spektrosk., Vol. 5, No. 6, 699-702 (1958). In Russian.

The "natural zero approximation" introduced by Vol'kenshtein, El'yashevich and Stepanov (1949) makes it possible to determine th approximate values of the frequencies of vibrations of molecules when the non-diagonal coefficients of total interaction are small. The author shows that, if these coefficients are small, simple relationships may be established between the frequencies of vibrations of triatomic non-linear hydrides (RH_2) and the corresponding frequencies of their deuterated derivatives (RHD and RD_2). These relations are called the rules of averages. These rules mak it possible to calculate simply the values of the zero and fundamenta vibrational frequencies of non-linear RHD molecules if the corresponding frequencies of RH_2 and RD_2 molecules are known. The rules are applied to calculate the zero and fundamental frequencies of HDO, HDS and HDSe. Satisfactory agreement was obtained between values calculated by the rules of averages and values obtained experimentally or by means of other calculations.
A.Tybulewic

539.1

7438. APPROXIMATE RELATIONSHIPS BETWEEN FREQUENCIES OF ISOTOPIC MOLECULES OF THE XY_4 TYPE.

A.S.Sverdlin.
Optika i Spektrosk., Vol. 5, No. 6, 702-4 (1958). In Russian.

Derives simple formulae for calculation of F_2-symmetry frequencies of isotopic modifications of tetrahedral molecules. The formulae obtained satisfy the product rule of Teller and Redlich (1935), but are more convenient to use than the latter rule. The formulae were checked by calculations of the ν_3' and ν_4' frequencies of CD_4, SiD_4 and GeD_4; the agreement between the calculated and empirical values was satisfactory.
A.Tybulewicz

539.1

7439. FORBIDDEN $\Delta m_S = \pm 1$, $\Delta m_I = \mp 1$ TRANSITIONS IN A VANADYL CHELATE.

W.A.Anderson and L.H.Piette.
J. chem. Phys., Vol. 30, No. 2, 591-2 (Feb., 1959).

The hyperfine structure of VO^{++} in vanadylacetyl-acetone has been investigated when the constant magnetic field and the radio-frequency field are parallel to each other. The relative intensities of the transitions calculated from perturbation theory are compared with the line intensities of the normal transitions.
G.I.W.Llewelyn

539.1

7440. ELECTRONIC STRUCTURE OF NITRIC OXIDE.

H.Brion, C.Moser and M.Yamazaki.
J. chem. Phys., Vol. 30, No. 3, 673-81 (March, 1959).

The self-consistent field (SCF) molecular orbitals for nitric oxide were calculated in the linear-combination-of-atomic-orbitals molecular orbital approximation (LCAO-MO) using 1s, 2s, and 2p Slater atomic functions. Three different calculations were made. (1) An "incomplete treatment" in which mixing between the inner orbitals, which contain only 1s functions, and outer orbitals, which contain orthogonalized 2s and 2p functions, is neglected; (2) A similar calculation, but here the outer orbitals are forced to be orthogonal to the inner orbitals; (3) The "complete treatment" in which a orbitals are combinations of 1s, 2s, and 2p functions. The single Slater determinant wave-function built from the orbitals calculated from the complete treatment gives a negative binding energy, but a limited configuration interaction calculation accounts for 26% of th observed binding energy. The agreement between the calculated an observed first ionization potential is very good. Certain aspects o the u.v. spectra seem to be reasonably well explained from this ca culation. The dipole moment is calculated to be 0.5 D (N^-O^+) as co pared to an observed value of 0.16 D with undetermined sign. Following Mulliken, atomic and overlap populations were calculate

539.

7441. ELECTRONIC STRUCTURE OF NEPTUNIUM HEXAFLUORIDE.

G.L.Goodman and M.Fred.
J. chem. Phys., Vol. 30, No. 3, 849-50 (March, 1959).

Using the ligand field theory, predictions in close agreement with experimental data are made for the magnetic and spectroscopic properties of NpF_6. G.I.W.Llewelyn

539.19

7442. APPLICATION OF ONE-CENTER WAVE FUNCTIONS TO TETRAHEDRAL SYMMETRIC HYDRID MOLECULES.
I. THEORETICAL BASIS OF THE METHOD. E.Kapuy.
Acta phys. Hungar., Vol. 9, No. 3, 317-33 (1959).

Methods are given for the development of the wave-function and the simplification of the computations. For molecules with a high degree of symmetry, this method seems to be successful.

539.19

7443. APPLICATION OF ONE-CENTER WAVE FUNCTIONS TO TETRAHEDRAL SYMMETRIC HYDRID MOLECULES.
II. NUMERICAL COMPUTATIONS FOR METHANE. E.Kapuy.
Acta phys. Hungar., Vol. 9, No. 4, 445-59 (1959).

Two different types of one-centre wave-function are used to calculate several physical constants of the CH_4 molecule. In spite of the great simplifications, fairly good results are obtained for energy, bond length and vibrational frequency, etc. However, the method cannot predict a correct binding energy. The sources of the inadequacies and the possibilities of improvement are investigated.

539.19

7444. CONTRIBUTION TO THE STUDY OF MOLECULAR WAVE-FUNCTIONS. I. C.Vroelant.
Cahiers de Phys., Vol. 11, 422-40 (Oct.-Nov., 1957). In French.

Account of an unconventional approach to electronic wave-functions, related to that described in Abstr. 6990-1 (1953). This part contains a general introduction to the problems involved, a detailed description of the Young diagrams of the irreducible representations of the permutation group, used in the spin theory, and a discussion of the effect of the singularities of the potential on the He atom wave-function. J.Hawgood

539.19

7445. SINGLE-CENTER WAVE FUNCTION FOR THE HYDROGEN MOLECULE. S.Hagstrom and H.Shull.
J. chem. Phys., Vol. 30, No. 5, 1314-22 (May, 1959).

The ground state of the hydrogen molecule is studied using an expansion based on a single centre, the molecular midpoint, with basis orbitals constructed from associated Laguerre functions with a single orbital exponent. The convergence of the expansion is studied by systematic addition of terms and is found to be slow. The best wave functions attained have energies of -1.15086 (38 axially symmetric terms), and -1.16141 (44 terms). The results are shown to be very similar to those obtained by using Slater orbitals with nonintegral principal quantum number both from the energy increments observed and from a natural spin orbital occupation number analysis. It is concluded that the slow convergence probably results from failure to represent adequately the singularities at the nuclei, and that further use of single-centre expansions in diatomic problems (except at very small internuclear distances) seems unprofitable, irrespective of what set of orbitals is used as a basis.

539.19

446. INTRA- AND INTERMOLECULAR RADIATIONLESS QUANTUM TRANSITIONS IN COMPLEX MOLECULES. H.Sponer.
Radiation Research, Suppl. No. 1, 558-76 (1959). See Abstr. 164 (1959).

Review, summarizing experimental studies and discussing ualitative theories of these phenomena, particularly predissociation and internal conversion and the conditions and selection ules governing their occurrence. Other topics include intramolecular sensitization, deactivation mechanisms and collisions f the second kind, and sensitized fluorescence and phosphorescence. 2 references. J.Hawgood

539.19 : 535.371

INTERNAL CONVERSION OF EXCITATION ENERGY IN ROMATIC MOLECULES AND CRYSTALS. See Abstr. 6764

539.19

447. ON THE ONE-CENTRE INTERACTION INTEGRALS IN HE MOLECULAR ORBITAL METHOD. W.Kołos.
cta phys. Polon, Vol. 16, No. 4, 299-301 (1957).

Use of a wave-function involving the interelectron distance rings the calculated values of these integrals near to the empirical alues used by Pariser and Parr. J.Hawgood

539.19

7448. ELECTRON SPIN RESONANCE OF NITROBENZENE NEGATIVE ION. R.L.Ward.
J. chem. Phys., Vol. 30, No. 3, 852-3 (March, 1959).

The electron spin resonance of nitrobenzene negative ion, prepared by the reaction of potassium with nitrobenzene in 1,2-dimethoxyethane, has been interpreted by means of deuterium substitution; and the hyperfine coupling constants with nuclei on different sites in the molecule has been determined. J.M.Baker

539.19

7449. ELECTRON SPIN RESONANCE ABSORPTION OF AROMATIC HYDROCARBON—IODINE COMPLEXES. Y.Matsunaga.
J. chem. Phys., Vol. 30, No. 3, 855-6 (March, 1959).

Electron spin resonance in a number of hydrocarbon—iodine complexes confirms the presence of unpaired electrons in these semiconductive molecular complexes. The estimated concentration of unpaired electrons is in good agreement with that derived from the deviation from the additivity rule for the molar susceptibility. J.M.Baker

539.19

7450. NUCLEAR QUADRUPOLE INTERACTIONS IN ALKALI HALIDE MOLECULES. T.P.Das and M.Karplus.
J. chem. Phys., Vol. 30, No. 3, 848-9 (March, 1959).

The authors have compared the theoretical values of the nuclear quadrupole coupling constants for both nuclei in each of the three molecules KCl, KBr, and RbCl for the $v = 0$ state and have compared them also with data obtained by the molecular beam technique. The inclusion of the polarization term brings the theoretical values for the positive ion nuclei in satisfactory agreement with experiment. However, the theory fails entirely for the negative ion nuclei. The authors believe that the overlap of orbitals on the halogen and alkali atoms must be taken into account. R.Schnurmann

539.19

7451. BOND CHARACTERS AND NUCLEAR QUADRUPOLE COUPLING CONSTANTS OF HALOGEN MOLECULES. H.Hamano.
J. chem. Phys., Vol. 30, No. 2, 598-9 (Feb., 1959).

The close agreement of the eQq values of Cl^{35} and Br^{69} in solid chlorine and bromine with those of the free atoms is investigated using the VB and MO theories. It is concluded that the double bond characters possible in the halogen bond orbitals are important in addition to the different amount of s characters. G.I.W.Llewelyn

539.19

7452. SINGLE-CENTER EXPANSIONS FOR ONE-ELECTRON SYSTEMS. H_2^+. K.M.Howell and H.Shull.
J. chem. Phys., Vol. 30, No. 3, 627-33 (March, 1959).

The expansion of the H_2^+ wave-function in terms of the set of associated Laguerre functions of order $(2l + 2)$ based on a single point in space, the molecular midpoint, is studied by the usual variational approach. In particular, the convergence of the expansion is studied as a function of the number and type of basis functions used, the respective scaling parameters, and the internuclear distance. A peculiar behaviour with respect to the scaling parameter, in which, for example, for certain optimum choices of the scale parameter for one group of basis functions no improvement is observed upon the addition of one more such function, is proved to occur generally for these functions with one-electron Hamiltonians. This behaviour emphasizes the necessity for treating such scale factors as mathematical parameters rather than as constants to be chosen by physical intuition. This single-centre expansion is concluded to be only slowly convergent and therefore, the authors feel, likely to have relatively limited use for quantitatively accurate calculations on more complex problems. Such expansions may, however, be useful for certain classes of excited states.

539.19

7453. MOLECULE FORMATION IN THE INERT GASES. N.Bernardes and H.Primakoff.
J. chem. Phys., Vol. 30, No. 3, 691-4 (March, 1959).

The Schrödinger energy eigenvalue equation for the relative motion of two inert gas atoms is solved approximately by fitting a Morse interatomic potential to the generally accepted Lennard-Jones 12-6 interatomic potential. A condition for binding is derived involving the phenomenological parameters present in the 12-6 potential; from the empirical values of these parameters one can then conclude that all the inert gases, except helium, do form stable diatomic molecules. A qualitative argument is presented showing that an hexatomic helium molecule may be stable. The vibration-rotation energy spectrum of the stable inert gas diatomic molecule is discussed. Finally, the partition function for the diatomic molecule is evaluated in an approximate way, whence, using the standard form for the equilibrium constant in terms of partition functions, it follows that at reasonable values of temperature and pressure several per cent of the atoms are associated in the form of diatomic molecules.

539.19

7454. ELECTRON COUPLING OF NUCLEAR SPINS. II. MOLECULAR ORBITAL INTERPRETATION OF COUPLING CONSTANTS OBSERVED IN FLUOROBENZENES.

G.A.Williams and H.S.Gutowsky.

J. chem. Phys., Vol. 30, No. 3, 717-23 (March, 1959).

For Pt I, see J. Amer. Chem. Soc., Vol. 79, No. 17, 4596 (1957). The H—H, H—F, and F—F coupling constants and relative signs determined previously in high resolution N.M.R. experiments are considered in terms of molecular orbital theory. The data, including the dependence of the coupling upon the relative positions of the atoms in the benzene ring, are sufficient to indicate which of the various interactions contribute most to the coupling. In general, the largest contribution is that carried by s electrons through the Fermi contact interaction. However, there are significant one-electron terms. The H—F and F—F coupling constants suggest that there is about 5% fluorine 2s character in the C—F bond.

539.19

7455. ESTIMATION OF S-ELECTRON PROMOTIONAL ENERGIES AND THE DEPENDENCE OF ORBITAL HYBRIDIZATION ON IONICITY.

J.K.Wilmshurst.

J. chem. Phys., Vol. 30, No. 4, 889-94 (April, 1959).

A simple electron pairing picture of the chemical bond is used to relate experimental valence state energies to the ionic character, orbital hybridization, and s-electron promotional energy of an atom. A number of s-electron promotional energies are estimated and, in every case, they are less than s-electron promotional energies calculated from atomic spectral data. The cause of this discrepancy is suggested as arising from a shifting of the energy levels of the valence electrons on bonding.

539.19

7456. CONJUGATION AND POLAR EFFECTS IN BUTADIENE.

R.S.Berry.

J. chem. Phys., Vol. 30, No. 4, 936-41 (April, 1959).

Various valence bond structure functions are projected on to approximate ground-state wave-functions of butadiene. The most important structure, C = C—C = C, contributes approximately 70% of the total. The next most important structure corresponds to two attractive dipoles and contributes over 40% to the ground state, while structures with double bonds between the central carbons contribute relatively little. It appears that ionic contributions may be important to the central carbon—carbon bond length, with the dipole—dipole interaction behaving like an effective repulsion because of the variation of the electronic wave-function. The problem of the non-orthogonal valence bond representation is examined: it is found that conjugation is strongly inherent even in a "nonconjugated" structure C = C—C = C, and that conjugation and dipolar interaction are nearly separable.

539.19

7457. CALCULATION OF n → π* TRANSITION ENERGIES IN N-HETEROCYCLIC MOLECULES BY A ONE-ELECTRON APPROXIMATION.

L.Goodman and R.W.Harrell.

J. chem. Phys., Vol. 30, No. 5, 1131-8 (May, 1959).

The one-electron LCAO-MO formalism is applied to n → π* transition energies in N-heterocyclic molecules. $|\beta_{n\pi}{}^{spec}|$ is shown to be ~1 eV smaller than $|{}^1\beta_{n\pi}{}^{spec}|$ for (n, π*) states possessing no nodes through nitrogen atoms. Reasonable values are ${}^1\beta_{n\pi}{}^{spec} \cong -2.3$ eV, ${}^3\beta_{n\pi}{}^{spec} \cong -2.0$ eV. Calculations of transition energies, both singlet—singlet and singlet—triplet, are made for 16 molecules, yielding semiquantitative agreement with experiment. Prediction of the assignment of the lowest excited singlet and triplet levels is made for a number of cases. The singlet—triplet split in the lowest (n, π*)configuration is predicted to undergo a strong orientation dependence in the 6-membered azines. Substitution effects are considered and orientation effects on the n → π* blue shift upon conjugative substitution are treated. (n, π*) states with nodes through nitrogen atoms are discussed qualitatively.

539.19

7458. UNITED ATOM TREATMENT OF THE BEHAVIOR OF POTENTIAL ENERGY CURVES OF DIATOMIC MOLECULES FOR SMALL R.

W.A.Bingel.

J. chem. Phys., Vol. 30, No. 5, 1250-3 (May, 1959).

It is shown that the potential energy function V(R) of any state of a diatomic molecule can be expanded for small internuclear distance in the form $V(R) = [(Z_a Z_b)/R] + W_u + E_2 \cdot R^2 + E_3 \cdot R^3 + \ldots$, where W_u is the energy of that state of the united atom to which the molecular state under consideration connects. Explicit expressions for the coefficients E_2, E_3 are given in terms of the electronic charge density of the united atom. Applications of the derived energy expansion are discussed.

539.19

7459. UNITED ATOM TREATMENT OF THE BEHAVIOR OF POTENTIAL ENERGY SURFACES OF POLYATOMIC MOLECULES AT SMALL INTERNUCLEAR DISTANCES.

W.A.Bingel.

J. chem. Phys., Vol. 30, No. 5, 1254-8 (May, 1959).

It is shown that the potential energy function of any state of a polyatomic molecule can be expanded for small internuclear distance in the form

$$V = \sum_{\alpha>\beta}\sum Z_\alpha Z_\beta / R_{\alpha\beta} + W_u + \sum_{\alpha}(E_{2\alpha} \cdot R_\alpha{}^2 + E_{3\alpha} \cdot R_\alpha{}^3 + \ldots),$$

where W_u is the energy of the particular state u of the united atom (UA) to which the molecular state in question connects, and R_α is the distance of the αth nucleus from the UA. Explicit expressions for the coefficients $E_{2\alpha}$, $E_{3\alpha}$ are given in terms of the electronic charge density of the UA. The derived energy expansion is applied to the molecules CH_4, NH_3, H_2O, and HF which all correspond to the united atom Ne.

539.19

7460. LCAO—MO SCF STUDY OF B_2.

A.A.Padgett and V.Griffing.

J. chem. Phys., Vol. 30, No. 5, 1286-91 (May, 1959).

An LCAO molecular orbital study of B_2 was made for three distances of the internuclear parameter. SCF molecular orbitals were obtained for the ${}^3\Sigma_g{}^-$ state, which is the reported ground state of the molecule. Total molecular energies of other low-lying states were calculated using the ${}^3\Sigma_g{}^-$ SCF molecular orbitals. These results indicate that the ${}^5\Sigma_u{}^-$ state is the ground state of B_2; however, the ${}^3\Sigma_g{}^-$ and ${}^3\Pi_u$ states lie only about 1.5 eV above the ${}^5\Sigma_u{}^-$ state and may become lower in a more refined calculation. A Mulliken electronic population analysis was applied to B_2. For comparative purposes a summary of overlap and atomic populations of Li_2, C_2, N_2, and O_2 is included.

539.1

7461. SOME CONSIDERATIONS ON THE VALIDITY OF THE ELECTROSTATIC MODEL FOR THE STUDY OF COMPLEXES.

C.Furlani.

R.C. Accad. Naz. Lincei, Vol. 25, No. 6, 488-94 (Dec., 1958).

In Italian.

Discusses the error introduced by regarding the electric charges as localized at a point. A numerical example shows that quite large errors can be introduced. J.M.Houg

539.1

7462. A METHOD FOR THE CALCULATION OF LOCALIZATIO ENERGIES.

J.Koutecký.

Trans Faraday Soc., Vol. 55, Pt 4, 505-9 (April, 1959).

A method is given which, in some cases, is helpful for the calculation of localization energies to the approximation of the simple molecular orbital method.

539.

7463. EFFECT OF THE SUBSTITUTION OF DEUTERIUM FOR HYDROGEN ON THE POLARIZABILITY OF MOLECULES.

I.B.Rabinovich and Z.V.Volokhova.

Dokl. Akad. Nauk SSSR, Vol. 122, No. 5, 844-7 (1958). In Russian.

The dispersion of light and the density were determined for t following compounds and their hydrogen analogues: C_6D_6, C_6D_5CH CD_3NO_2, $CDBr_2CDBr_2$, $CDCl_3$, $CH_2ODCHODCH_2OD$, CH_2ODCH_2OD, CH_3OD, C_2H_5OD, $CH_3(CH_2)_2OD$, $(CH_3)_2CHOD$, CH_3COOD, after whic their static polarizability was calculated. It was found that these D compounds have a lower refractive index and a smaller polarizability than their H analogues. By making a few simplifying assumptions, the authors find theoretically that, while the intermolecular dispersion energy ought to be lower for D than for the corresponding H compounds at medium temperatures, this relationship should be reversed at low temperatures (c.f. Rabinovich and Gorbushenkov, Abstr. 7863/1958). F.Lachman

539.19

7464. NUCLEAR MAGNETIC RESONANCE SPECTRA OF HEXABORANE. R.E.Williams, S.G.Gibbins and I.Shapiro.
J. chem. Phys., Vol. 30, No. 1, 333-4 (Jan., 1959).

The high resolution B^{11} and proton spectra of hexaborane and pentaborane-9 are used to elucidate their structure and the conclusions are compared with those of X-ray analysis (Hirshfeld et al., Abstr. 796/1958). A pentagonal pyramid structure is favoured but there is disagreement with X-rays about charge densities.
J.G.Powles

539.19

7465. MOLECULAR STRUCTURE OF TIN TETRACHLORIDE. R.L.Livingston and C.N.R.Rao.
J. chem. Phys., Vol. 30, No. 1, 339-40 (Jan., 1959).

On the basis of refined electron diffraction measurements, in which a rotating sector was used, it is concluded that the structure of tin tetrachloride is tetrahedral, as found from earlier electron diffraction studies. The "square pyramidal" model put forward by Tourky and Rizk was found to be inconsistent with the observed results. J.Thewlis

539.19

7466. LOW-TEMPERATURE X-RAY STUDIES OF RICE'S BLUE MATERIAL. L.H.Bolz, F.A.Mauer and H.S.Peiser.
J. chem. Phys., Vol. 30, No. 1, 349-50 (Jan., 1959).

It has not been found possible to define the character of the blue decomposition material formed on passing HN_3 vapour at low pressure through a Tesla-coil discharge. X-ray diffraction observations obtained at different temperatures are discussed.
G.I.W.Llewelyn

539.19

7467. NITRYL CHLORIDE MOLECULAR CONSTANTS FROM MICROWAVE SPECTRUM ANALYSIS.
L.Clayton, Q.Williams and T.L.Weatherly.
J. chem. Phys., Vol. 30, No. 5, 1328-34 (May, 1959).

The microwave spectrum of NO_2Cl was studied in the region 25 000 to 40 600 Mc/s and an analysis made of the J = 2 → 3 and 3 → 4 transitions. The following molecular constants were obtained:

	NO_2Cl^{35}	NO_2Cl^{37}
Rotational constants (Mc/s)		
A	13 250	13 250
B	5173.8	5019.0
C	3721.1	3640.4
Asymmetry parameter		
κ	−0.6951	−0.7131
Quadrupole coupling constants (Mc/s)		
χ_{aa}	−94.70	−74.58
χ_{bb}	52.4	41.3
χ_{cc}	42.3	33.3

he structural parameters obtained from these are d(Cl—N) = 1.83 A, N—O) = 1.21 A, and O—N—O angle 129.5°. The dipole moment lculated from the Stark effect is 0.53 Debye. Implications of the orementioned results are discussed.

539.19 : 541.122

MOLECULAR STRUCTURE OF SUBSTITUTED ϵ-CAPROLAC-AM. See Abstr. 6337

539.19 : 532.133

THE RELATIONSHIP BETWEEN VISCOSITY AND MOLECULAR RUCTURE. See Abstr. 6571

539.19 : 535.343

VIBRATIONAL ANALYSIS OF 4,4-DIMETHYLCYCLOPENTENE. e Abstr. 6742

539.19 : 535.343

BARRIER TO INTERNAL ROTATION, AND STRUCTURE OF ETHYL FORMATE. See Abstr. 6746

539.19

7468. SIMPLE EQUATION FOR ESTIMATING THE DIPOLE MOMENT OF A MOLECULE FROM SOLUTION DATA.
S.C.Srivastava and P.Charandas.
J. chem. Phys., Vol. 30, No. 3, 816-18 (March, 1959).

A simple empirical equation for estimating the dipole moment of a molecule from dielectric constant measurement in solutions without any density and refraction data is suggested. The equation has been shown to be derived from an approximation of the Guggenheim—Smith equation for orientational polarization, as modified by Palit.

539.19

7469. DIRECT METHOD OF MEASURING MOLECULAR QUADRUPOLE MOMENTS. A.D.Buckingham.
J. chem. Phys., Vol. 30, No. 6, 1580-5 (June, 1959).

An experiment whose object is the determination of permanent molecular quadrupole moments is suggested. It is analogous to those used in measurements of electro-optical Kerr constants, but the uniform electric field proportional to the applied voltage V is replaced by the field gradient of a square four-wire condenser. If the wires at x = ±a are at a potential V relative to those at y = ±a, then the field gradient on the z axis will tend to orient quadrupole molecules so that a fluid in the condenser will become doubly refracting. The induced anisotropy in the refractive index of a gas is shown to be first order in the applied voltage and of the form $n_x - n_y = [B + (A/T)]V$, while in the Kerr effect it is second order in V, and is given by $n_x - n_y = [C + (D/T) + (E/T^2)]V^2$. The constant A is proportional to the molecular quadrupole moment and to the anisotropy in the polarizability, while B is proportional to the quadrupole moment induced in a molecule by a uniform field. In spherical molecules A, D, and E are zero. Calculations indicate that measurements of $n_x - n_y$, leading to accurate molecular quadrupole moments should be practicable with present-day equipment. The theory of the effect in dense media is also developed.

539.19

7470. CHANGES IN MOLECULAR DIPOLE MOMENTS ON DISTORTION. J.W.Linnett and B.G.Reuben.
Trans Faraday Soc., Vol. 55, Pt 4, 510-14 (April, 1959).

Results have been obtained for the methyl halides by supposing that the difference between the two values obtained for $\partial\mu CH/\partial\mu CH$ is due to the high polarizability of the halogen atom. In order to account for the differences, reasonable values for the polarizabilities of the halogen atoms have to be assumed. An alternative treatment, in which the halogen atoms are treated as charged spheres of radius a, is also examined. It is found that the experimental values of $\partial\mu CH/\partial\mu CH$ require values of a which are not unreasonable. Ethane and ethylene have also been studied briefly.

539.19 : 535.343

7471. MICROWAVE SPECTRUM, MOLECULAR STRUCTURE OF VINYL CYANIDE AND A SUMMARY OF CC, CH BOND LENGTHS IN SIMPLE MOLECULES. C.C.Costain and B.P.Stoicheff.
J. chem. Phys., Vol. 30, No. 3, 777-82 (March, 1959).

The microwave spectra of six isotopic species of vinyl cyanide (acrylonitrile) CH_2CHCN were investigated. From the rotational constants it is shown that the molecule is planar, and has the following structural parameters (exclusive of the CH_2 group):

$$r_s(C{\equiv}N) = 1.163_7A,\ r_s(C{-}H) = 1.086_3A,$$
$$r_s(C{-}C) = 1.425_6A,\ \angle C{=}C{-}C = 122^\circ37',$$
$$r_s(C{=}C) = 1.338_9A,\ \angle H{-}C{-}C = 121^\circ44',$$

The quadrupole hyperfine structure was interpreted according to the asymmetric top treatment leading to a value of eqQ = −4.21 ± 0.04 Mc/s for the quadrupole coupling constant along the C≡N bond. A table of the most accurate published values of CC and CH bond lengths is included. A graphical presentation of these results shows that the C—C, C═C, and C—H bond lengths vary linearly with the number of adjacent bonds.

539.19 : 541.183

7472. β-TYPE INTERLAMELLAR SORPTION COMPLEXES.
F.Aragón, J.Cano Ruiz and D.M.C.MacEwan.
Nature (London), Vol. 183, 740-1 (March 14, 1959).

Gives results of experiments on the spatial configuration of straight-chain amines and alcohols sorbed on graphitic acid and montmorillonite. J.Hawgood

539.19 : 541.14

STRUCTURE OF NITROXYL, HNO. See Abstr. 6350

539.19

7473. NONRESONANT ABSORPTION OF SYMMETRIC TOP MOLECULES. COLLISION CROSS SECTION.

G.Birnbaum and A.A.Maryott.

J. chem. Phys., Vol. 29, No. 6, 1422-3 (Dec., 1958).

It is suggested that the pressure broadening is governed by the change in angular momentum of a molecular dipole in a collision with another. Dimensional considerations lead to a correlation of the line widths with dipole moments and angular momentum values, and a predicted temperature dependence, which are empirically successful. J.Hawgood

539.19

7474. SEGMENTAL MOTION IN POLYBUTENE –1.

A.E.Woodward, J.A.Sauer and R.A.Wall.

J. chem. Phys., Vol. 30, No. 3, 854-5 (March, 1959).

The variation of dynamic mechanical properties of a partially crystalline sample with temperature between 80° K and 400° K is interpreted in terms of the mobility of the polymer chains.

G.I.W.Llewelyn

539.19

7475. CORRELATION SCHEME FOR DIATOMIC OXIDES.

J.Berkowitz.

J. chem. Phys., Vol. 30, No. 3, 858-60 (March, 1959).

A generalized scheme based on isoelectronic principles is proposed to correlate recorded data on the dissociation energies of metallic oxides. Results for the first two rows of the periodic chart are tabulated. G.I.W.Llewelyn

539.19

7476. DETERMINATION OF INTERMOLECULAR POTENTIALS FROM THERMODYNAMIC DATA AND THE LAW OF CORRESPONDING STATES.

J.B.Keller and B.Zumino.

J. chem. Phys., Vol. 30, No. 5, 1351-3 (May, 1959).

It is shown that in classical statistical mechanics the second virial coefficient in the virial expansion of the equation of state of a gas uniquely determines the intermolecular potential provided that the potential is monotonic (i.e., everywhere repulsive or everywhere attractive). This result leads to a partial verification of a conjecture of Kammerlingh-Onnes and Keesom concerning the Law of Corresponding States. An explicit formula for the potential is also obtained. If the potential is not monotonic it is not uniquely determined by the second virial coefficient. All potentials corresponding to a given second virial coefficient are determined explicitly.

539.19

7477. STATISTICS OF DEFORMABLE MOLECULAR CHAINS.

A.Borsellino.

J. chem. Phys., Vol. 30, No. 3, 857-8 (March, 1959).

Direct solutions of many problems can be made if the algebraic properties of the average matrix $\langle R \rangle$, which gives the average angular connection between successive links in the chain, are utilized. Expressions are derived for the end-to-end distance of a chain and for the mean radius of gyration. R.F.Barrow

539.19

7478. DETERMINATION OF TRANSITION MOMENT ORIENTATION IN PARTIALLY ORIENTED POLYMERS.

R.D.B.Fraser.

J. chem.Phys., Vol. 29, No. 6, 1428-9 (Dec., 1958).

The case is considered of axially oriented polymers in which each chain is linear with a series of independent absorbing groups whose transition moment directions are inclined at an angle α to the molecular axis. Relations are given from which limiting values of α may be derived from experimental dichroic ratios.

R.F.Barrow

539.19

7479. NEW METHOD FOR THE STATISTICAL COMPUTATION OF POLYMER DIMENSIONS.

F.T.Wall and J.J.Erpenbeck.

J. chem. Phys., Vol. 30, No. 3, 634-7 (March, 1959).

A new method is described for the generation of excluded volume random walks of contour lengths comparable to those of real polymer molecules. This work was carried out with a high-speed electronic digital computer. An essential feature of the method is an unbiased sample enrichment process used to counteract the attrition resulting from chain intersections. Using the new method, samples were generated for chains of 800 links, a limit imposed by machine storage capacity. In principle the method could be carried even further if more storage were available. Mean-squar end-to-end lengths of the chains are expressed by the equation

$$\langle r_n^2 = an^b, \rangle$$

where n equals the number of links and a and b are constants.

539.19

7480. STATISTICAL COMPUTATION OF RADII OF GYRATION AND MEAN INTERNAL DIMENSIONS OF POLYMER MOLECULES.

F.T.Wall and J.J.Erpenbeck.

J. chem. Phys., Vol. 30, No. 3, 637-40 (March, 1959).

A Monte Carlo numerical method has been employed for the computation of the mean-square separation between pairs of elements i and j, $\langle R_{ij}^2 \rangle$, and the mean-square radius of gyration $\langle S_n^2 \rangle$, for an n-segment coiling type polymer molecule. A restricted random walk was used as a model for the polymer, and the average dimensions in question were calculated for random samples of non-intersecting walks generated by means of a high-speed digital computer. $\langle R_{ij}^2 \rangle$ has been found to be a rather complicated function of i/n and j/n, depending upon the position in the chain as well as upon the contour length of the segment between i and j. The mean-square radius of gyration was found to be proportional to the average squar end-to-end distance, as for simple unrestricted random walks, but the constant of proportionality differs from the value of $\frac{1}{6}$ which is applicable in the absence of the excluded volume effect. The exact value of the ratio of the two quantities depends upon whether the molecule is constrained to 2 or 3 dimensions.

539.19 : 538.27

EFFECT OF PARAMAGNETIC IONS ON THE NUCLEAR MAGNETIC RESONANCE OF O^{17} IN WATER AND THE RATE OF ELIMINATION OF WATER MOLECULES FROM THE FIRST COORDINATION SPHERE OF CATIONS. See Abstr. 7198

539.19

7481. ON CHEMICAL EQUILIBRIUM AMONG THE POLYMERS OF THE ALKALI HALIDFS.

M.Eisenstadt, V.S.Rao and G.M.Rothberg.

J. chem. Phys., Vol. 30, No. 2, 604-5 (Feb., 1959).

Doubt concerning the attainment of chemical equilibrium before the gas leaves the effusion cell in the study of the polymerization in alkali halide vapours is resolved by the use of a large double oven in which the molecules spend about 25 seconds before effusing. The evidence suggests that equilibrium is very nearly approached in small ovens. The polymerization of NaCl was investigated and the dissociation energy of $(NaCl)_2$ into 2 NaCl was found to be 47.9 ± 0.6 kcal per mole. W.Goo

539.1

7482. MOLECULAR CONFIGURATIONS OF VINYL POLYMERS WITH STRICTLY REGULAR STRUCTURES AND THEIR MEAN DIMENSIONS AND ELECTRIC MOMENTS IN DILUTE SOLUTIONS.

K.Nagai.

J. chem. Phys., Vol. 30, No. 3, 660-72 (March, 1959).

Neglecting the long-range interaction between segments, general expressions for the mean dimensions and the electric moments of isotactic and syndyotactic vinyl polymers in dilute solu tions are derived. For the comparison with experimental results, the following expression is employed for the potential energy of the hindered rotation around C—C links of a skeletal chain:

$$E = (E_0/2)[1-\cos(\theta-\theta_0)],$$

where θ is a twisted angle from the trans position with θ_0 as the most probable one, and E is the maximum height of the potential energy. For simplicity numerical calculations of the electric moments are restricted to vinyl polymers in which the direction of th electric moment vector of each substituted group coincides with o of four symmetry axes of tetrahedral model of carbon atom. For isotactic polymers three cases are examined. The first: all C—C links are twisted in the same manner. The second: consecutive t C—C links are twisted to inverse directions to each other. The third: potential energies of the hindered rotation around C—C link have their minima at the same angles as in crystalline state. Fro consideration of the minimum distance between two adjacent subst tuted groups, it is concluded that, if the molecular dimension of is tactic polystyrene is not far apart from that of atactic polystyrene the deformation of the second type would be less probable. When taken into account the collisions between different parts of the pol mer molecule, the deformation of the third type or the other similar t it may be most probable. In this case $\langle R^2 \rangle / nb^2$ is taken to be

12 ~ 13, then $\langle u^2\rangle/Nu_0^2$ should become 1.5 ~ 1.7, $N = n/2$ being degree of polymerization. For syndyotactic polymers, two unknown parameters involved in the theory may be uniquely determined by measuring $\langle R^2\rangle/nb^2$ and $\langle u^2\rangle/Nu_0^2$.

539.19

7483. CHARACTERIZATION OF POLYMER STRUCTURES ON HELICAL POINT NETS. R.E.Hughes and J.L.Lauer.
J. chem. Phys., Vol. 30, No. 5, 1165-70 (May, 1959).

The extension of a polymer chain through many contiguous unit cells in a crystallite requires a discrete relationship between the crystallographic translation identity period and the structural identity period within the chain. This relationship can be uniquely expressed by describing the chain structure in terms of a helical point net. Helical point nets can be defined in terms of standard screw axis nomenclature, using the translation-rotation operators p_q. Integral values of the p's and q's produce all possible nets and their enantiomorphs. The net points thus defined have the property of identity through the operators p_q. The chain structures of polymers in the crystalline state can thus be defined simply in terms of the structure about one net point. Introduction of the restrictions of bond distances and angles limits the number of possible nets for a given translation identity period. One-atom and two-atom structures are considered in detail, and the extension to multiatom structures is indicated.

539.19

7484. SPECTROSCOPIC EVIDENCE FOR TRIATOMIC NITROGEN IN SOLIDS AT VERY LOW TEMPERATURE.
M.Peyron, E.M.Hörl, H.W.Brown and H.P.Broida.
J. chem. Phys., Vol. 30, No. 5, 1304-10 (May, 1959).

Additional wavelength, intensity, and lifetime measurements of the radiation emitted from solid nitrogen containing trapped atoms have led to the interpretation that a weakly bound triatomic molecule, N_2—N, is an emitting species. The three lowest electronic levels of atomic nitrogen ^{2}P, ^{2}D, and ^{4}S are involved in the 8 line groups which were found. Isotopic substitution has confirmed this model. Evidence was also found for an N_2—O molecule similar to the N_2—N.

539.19

7485. NOTE ON THE NORMAL STRESS EFFECT IN THE SOLUTION OF RODLIKE MACROMOLECULES. T.Kotaka.
J. chem. Phys., Vol. 30, No. 6, 1566-7 (June, 1959).

Three components of normal stresses in a solution of rodlike macromolecules are calculated on the basis of the general theory of irreversible processes of macromolecular solutions developed by Kirkwood (1949, 1954). The results are expressed in expansion series of even powers of the rate of shear and are explicitly given to their fourth powers. When the hydrodynamic interaction is not taken into account, two components of the normal stresses perpendicular to the direction of flow identically vanish, while, by the introduction of this interaction, they appear. The action of normal stresses is still mainly "pull" in the direction of flow as in the free-draining case.

539.19 : 537.56

COLLISION CROSS-SECTION STUDIES ON MOLECULAR GASES AND THE DISSOCIATION OF OXYGEN AND WATER. See Abstr. 7130

539.19

486. UNPAIRED ELECTRONS IN CARBON BLACKS.
R.L.Collins, M.D.Bell and G.Kraus.
J. appl. Phys., Vol. 30, No. 1, 56-62 (Jan., 1959).

An appreciable concentration of unpaired electrons was found in colloidal carbon blacks through the application of electron spin resonance spectroscopy. The unpaired electrons in a typical channel process carbon black, Spheron 6, were studied by noting the changes in the electron spin resonance spectrum produced by heat treatment HT) to 3000° C and by various degrees of evacuation of the sample. The results indicate that the unpaired electrons in the original material are mobile π electrons, which are stabilized by condensed aromatic ring structures. Their concentration decreases slowly to 50° C HT and then declines more rapidly and vanishes above 1400° C HT. A different species of unpaired electrons arises at 1400° C HT. These are believed to be immobile σ electrons resulting from broken carbon-carbon bonds at lattice defects. The unpaired electrons present in several commercial carbon blacks were examined and are believed to be π electrons also. A tentative theory of the origin of the unpaired electrons is given.

SOLID-STATE PHYSICS

539.2

7487. HUGONIOT EQUATION OF STATE OF ALUMINUM AND STEEL FROM OBLIQUE SHOCK MEASUREMENT.
S.Katz, D.G.Doran and D.R.Curran.
J. appl. Phys., Vol. 30, No. 4(1), 568-76 (April, 1959).

A method using an explosive-produced oblique shock in a wedge-shaped specimen was developed for determining the Hugoniot equation of state of solids. Simultaneous measurements of shock and free-surface velocities along the wedge face permit calculation from a single shot of pressure and density over a pressure range exceeding 2:1. Aluminium was studied over the range 40-180 kb, good agreement being obtained with the normal-shock method. The data for low-carbon steel may be qualitatively interpreted in terms of a double-shock system, associated with the polymorphic transition from α- to γ-iron proposed by Minshall and Bancroft. The present method may provide a means for measuring the pressure at which a solid undergoes a polymorphic transition under dynamic conditions. Preliminary results for antimony indicate a dynamic phase transition at 95 kb corresponding to the one observed statically at 84 kb.

539.2

7488. BORN'S AND HUND'S BASIC POTENTIAL AS USEFUL TOOLS FOR CALCULATING MADELUNG'S COEFFICIENTS OF COMPLEX CRYSTALS. Y.Sakamoto and U.Takahasi.
J. chem. Phys., Vol. 30, No. 1, 337-8 (Jan., 1959).

Revised values of Born's potential $\Pi(p/12)$ have been calculated by using Emersleben's identities (Abstr. 5102/1955). With the aid of these revised values and the relation between Hund's potential $\Psi(q/n)$ and $\Pi(p/n)$ the authors point out that the constants appearing in the expression for the Madelung coefficients may be easily found.
R.Bullough

539.2

7489. THE VARIATION OF VIBRATION AMPLITUDES WITH TEMPERATURE IN SOME MOLECULAR CRYSTALS.
D.W.J.Cruickshank.
Acta cryst., Vol. 10, Pt. 12, 1005-9 (Dec., 1956).

The theory of the translational and rotational vibrations of molecules in molecular crystals is discussed. Characteristic lattice frequencies for translational and rotational vibrations, derived from X-ray and Raman studies, are used to predict the variation amplitudes with temperature in benzene, naphthalene and anthracene. There will be little gain in using temperatures below about 25° K for studies of the fine details of the electron density of these molecules.

539.2 : 548.74

7490. ANHARMONIC OSCILLATIONS OF NUCLEI. J.A.Ibers.
Acta cryst., Vol. 12, Pt 3, 251-2 (March, 1959).

It is shown that the difference between the equilibrium distance and the time-average distance between nuclei, caused by the anharmonicity of the oscillations, may be of the order of the errors in measurements of internuclear distances by neutron diffraction, especially when light nuclei are involved.
J.Hawgood

539.2

7491. INTERATOMIC-FORCE CONSTANTS FROM A CENTRAL-FORCE LAW. H.Cole.
I.B.M. J. Res. Developm., Vol. 3, No. 2, 126-31 (April, 1959).

These constants may be predicted from standard central-force laws using thermodynamic data. For the three cases where diffraction data are available (aluminium, copper, and iron) the predicted values agree within an order of magnitude for aluminium and iron, but differ strongly in the case of copper. It is suggested that Jacobsen's α_1, for copper, represents the strongest departure from a central-force model and should therefore be the most promising point for further theoretical work (Abstr. 3258/1955).

539.2 : 537.311.33

BINDING PROPERTIES OF $A^{III}B^{V}$ COMPOUNDS.
See Abstr. 6936

539.2

7492. THE VIBRATION SPECTRA OF DISORDERED LATTICES.
C.Domb, A.A.Maradudin, E.W.Montroll and G.H.Weiss.
J. Phys. Chem. Solids, Vol. 8, 419-20, 421-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The moments of the spectrum of the disordered crystal lattice can be calculated and much simplified by using the theory of random walks on lattices. Using moments up to the 20th, frequency distributions for different mass ratios (two component, one dimensional lattice) and concentrations are calculated. Specific spectral features emerge from the calculations. G.F.J.Garlick

539.2

7493. ON DISORDERED ONE-DIMENSIONAL CRYSTALS. P.Dean.
Proc. Phys. Soc., Vol. 73, Pt 3, 413-21 (March, 1959).

A mathematical method is presented which leads in a direct manner both to an explicit expression for the frequency distribution of a disordered chain of atoms and to a powerful technique for the numerical evaluation of the spectrum. The application of the method to a model of a binary alloy is then considered.

539.2 : 539.12

7494. THE NEUTRON–PHONON INTERACTION IN SOLIDS. B.Buras and D.O'Connor.
Nukleonika, Vol. 4, No. 2, 119-40 (1959).

A description is given of the main features of the interaction of thermal neutrons with crystal lattice vibrations. Experimental methods used in the study of this problem are compared, and recent work using these methods is reviewed. Some details of apparatus built in the authors' laboratory are given.

539.2

7495. NUCLEAR RELAXATION IN ALUMINUM. J.J.Spokas and C.P.Slichter.
Phys. Rev., Vol. 113, No. 6, 1462-72 (March 15, 1959).

Nuclear spin–lattice relaxation times T_1 and phase memory times T_2 have been measured in 99.99% pure aluminum foil from 77°K to the melting point by the spin-echo method. At high temperature the line narrows due to self-diffusion, as previously observed by Seymour. The temperature dependence of the narrowing gives an activation energy of self-diffusion E_D of 1.4 ± 0.1 eV. From the measured "narrowing temperature" and Nowick's theoretical estimate of D_0, the same value of E_D is found. As predicted theoretically, measurements show that T_1 arises from interaction with conduction electrons and is inversely proportional to temperature from 1°K to 930°K. At the highest temperatures, an unknown line-broadening mechanism is found which is believed to represent quadrupole coupling to strain fields of dislocations. The measurements were made feasible only through the use of a phase-coherent detection system, a description of which is given.

539.2

7496. THEORY OF ULTRASONIC CYCLOTRON RESONANCE IN METALS AT LOW TEMPERATURES. T.Kjeldaas,Jr.
Phys. Rev., Vol. 113, No. 6, 1473-8 (March 15, 1959).

The extent to which measurement of the propagation characteristics of circularly polarized acoustic shear waves as a function of a magnetic field applied parallel to the direction of propagation can reveal information about the band structure of metals is investigated theoretically. The interaction between the electrons and sound waves is treated classically and is viewed as taking place via an internal electric field and by scattering modified by the sound wave. The treatment is based on the combined solution of Boltzmann's and Maxwell's equations for a free-electron model. A simple physical picture involving cyclotron resonance is developed by means of which the treatment is extended to more general band models. The most striking results are obtained in case the mean free path is larger than the wavelength. Under these conditions, it is found that subject to certain restrictions, (1) absorption edges exist, the measurement of which can be related to the curvature of the Fermi-surface; (2) the shape of the Fermi-surface may be determinable from the shape of attenuation and dispersion curves within the absorption region; and (3) the cyclotron frequency may be measured. The results (2) and (3) may be dependent upon the simplifying assumption regarding the electron sound wave interaction.

539.2

7497. ELECTRONIC BAND STRUCTURES OF THE ALKALI METALS AND OF THE NOBLE METALS AND THEIR α-PHASE ALLOYS. M.H.Cohen and V.Heine.
Advances in Phys., Vol. 7, 395-434 (Oct., 1958).

In the monovalent metals the electronic band structure is strongly affected by the size of the band gap $E_s - E_p$ at the Brillouin zone faces, a large gap implying a large distortion of the Fermi surface. Here E_s and E_p are the energies of the purely s-like and p-like states on the zone faces. Crude estimates are made of $E_s - E_p$ for the alkali and noble metals, in terms of the s – p excitation energy Δ_{sp} of the free atoms. These suggest a single model which correlates most of the experimental information about the band structures of these metals. In particular the Fermi surface of lithium appears to make considerable contact with the zone faces. In the α-phase alloys of the noble metals, the solute always has a larger value of Δ_{sp} than the solvent, which raises the energy E_p relative to E_s. The Fermi surface becomes more nearly spherical in copper alloys than in copper, since $E_p < E_s$, whereas it distorts further in the gold alloys ($E_p > E_s$). This accounts for many Knight shift, electronic specific heat, magnetic susceptibility and other data on these alloys. Furthermore, it provides the extension of Jones' explanation of the Hume-Rothery rule demanded by the non-spherical Fermi surface in pure copper and gold.

539.2

7498. CALCULATION OF ELECTRONIC ENERGY BANDS IN ZnS. J.L.Birman.
J. Phys. Chem. Solids, Vol. 8, 35-7, 50-1 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Cellular methods are applied to the problem of the band energies in the two different crystal forms zinc blende and wurtzite. The boundary discontinuities are discussed for mixed blende—wurtzite, the barriers at such places being related to the partly polar nature of the ZnS bonds. G.F.J.Garlick

539.2

7499. COHESIVE ENERGIES AND BAND STRUCTURES OF COVALENCE AND IONIC CRYSTALS. A.Morita.
J. Phys. Chem. Solids, Vol. 8, 363-6, 379-81 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The SLCO (Semilocalized Crystalline Orbit) method is applied to the computation of the cohesive energy of the LiH crystal, and of the structure of the valence and conduction bands of silicon and germanium crystals. J.B.Birks

539.2

7500. ENERGY BAND STRUCTURE OF SODIUM ATOMS IN THE DIAMOND LATTICE. F.Bassani.
J. Phys. Chem. Solids, Vol. 8, 375-7, 379-81 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). An orthogonalized plane wave calculation for this hypothetica system gives a band structure very like that of Si, suggesting that the sequence of bands is determined by symmetry, and their separation by the electron density. J.Hawgood

539.2

7501. ENERGY-BAND STRUCTURE OF LITHIUM ATOMS IN THE DIAMOND LATTICE. F.Bassani and V.Celli.
Nuovo Cimento, Vol. 11, No. 6, 805-15 (March 16, 1959).

A hypothetical crystal of lithium atoms in the diamond lattice is considered. The value of the energies at the special points of the reduced zone with $k = (0, 0, 0)$, $k = 2\pi a^{-1}(1, 0, 0)$, $k = 2\pi a^{-1}(\frac{1}{2}, 0, 0)$ and $k = 2\pi a^{-1}(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$ are calculated by the orthogonalized-plane-wave method using the Wigner–Seitz crystal potential and the same electron density as in metallic lithium. The curves of energy versu k are drawn in the [1, 0, 0] and [1, 1, 1] directions. The energy bands so obtained are compared with the energy bands of diamond evaluated by F.Herman. The relative positions of the energy bands appear to be the same in the two cases and this points to the possibility that the energy-band structure is mainly determined by the symmetry of the lattice. A comparison with metallic lithium gives a higher cohesive energy in the case of the pseudolattice, when one neglects electrostatic, exchange and correlation terms.

539.2 : 537.311.3

THE CONNECTION BETWEEN BONDS AND BANDS IN METALS AND SEMICONDUCTORS. See Abstr. 6912

539.2 : 537.311.3

ENERGY BANDS OF SILICON AND GERMANIUM. See Abstr. 6966

539.2 : 537.311.3

BAND STRUCTURE CALCULATIONS OF SEMICONDUCTORS BY THE KOHN–ROSTOKER–KORRINGA METHOD: APPLICATIC TO GERMANIUM. See Abstr. 6967

53

7502. SOLUTION OF A PROBLEM ON SPLITTING OF ENERGY LEVELS OF RARE-EARTH IONS IN THE FIELD OF A CRYSTAL LATTICE. N.V.Afanas'eva.
Optika i Spektrosk., Vol. 5, No. 6, 629-33 (1958). In Russian.

The author calculated the energy levels of rare-earth ions in field of cubic symmetry using the method of operator-equivalents (Abstr. 3765/1952). The parameters of the electrostatic crystal field (magnetic fields were neglected) were found from paramagnetic resonance and optical data for ethyl sulphates and double nitrates of rare earths. A.Tybulewicz

539.2 : 539.12

7503. CORRELATION OF ANNIHILATION RADIATION IN ORIENTED SINGLE METAL CRYSTALS. S.Berko and J.S.Plaskett.
Phys. Rev., Vol. 112, No. 6, 1877-87 (Dec. 15, 1958).

Precision measurements of the two-photon annihilation in crystals of Al and Cu are presented. These show relatively small variation with crystal orientation. This is interpreted to mean that he strong high-momentum tail in the Cu distribution is due to annihilation with the 3d electrons and that the Fermi surface in Al is very nearly spherical but has slight bulges in the [100] and [111] directions. One-electron calculations of the distributions for Cu and Al agree quite well with the experiments and further confirm the mportance of core annihilation in Cu. The calculated positron ifetime in Cu does not disagree with previous experimental observaions by more than a factor of two. Electron—positron correlation by ny factor much larger than this is therefore precluded.

539.2

504. EXCITON—LATTICE INTERACTION AND A THEORY OF HE LINE SHAPE OF EXCITON ABSORPTION BANDS.
.Toyozawa.
. Phys. Chem. Solids, Vol. 8, 289-90, 302-4 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 569/1959). The exciton—lattice interaction Hamiltonian is derived ith the use of Wannier functions. The Lorentzian shape and aussian shape of the absorption band are especially investigated nd results are in qualitative agreement with experimental data. he Hamiltonian can also be used to estimate the cross-section for arious elementary processes relating to excitons.
L.Pincherle

539.2

505. METALLOGRAPHIC METHODS OF DETERMINATION OF HE DISLOCATION DENSITY IN GERMANIUM MONOCRYSTALS.
.Dragoun.
zech. J. Phys., Vol. 8, No. 5, 600-11 (1958). In Russian with ummary (1 p.) in English.

Dislocations in semiconducting crystals affect adversely their lectrical properties. The dislocation density can be deduced from e number and structure of etch-pits. The author reviews etching ethods of determination of the dislocation density in crystals and scribes a new method of selective etching followed by non-selective ching. This method was applied to germanium monocrystals to find at dislocation density in them was between 10^3 and 10^5 cm^{-2} (mainly ge dislocations). The results are illustrated by 9 clear microotograms (plates). A.Tybulewicz

539.2

06. SELECTIVE DELINEATION OF SCREW DISLOCATIONS Y CATHODIC SPUTTERING. B.B.Meckel and R.A.Swalin.
appl. Phys., Vol. 30, No. 1, 89-93 (Jan., 1959).

A method of revealing screw component dislocations involving w-energy cathodic sputtering with argon ions is presented. It is served that hillocks having the shape of truncated cones with a iral pattern on their tops form at the sites of intersection of screw slocations with the surface. The hillocks probably form by mobile rface atoms attaching themselves to the step provided at the interction of a screw dislocation with the surface. It is shown that the nsity of screw dislocations on a given plane depends on the orientn of the plane with respect to the crystal growth axis.

539.2 : 548.5

07. DISLOCATION ETCH PITS IN BISMUTH.
C.Lovell and J.H.Wernick.
appl. Phys., Vol. 30, No. 2, 234-5 (Feb., 1959).

Etch pits which are probably the sites of dislocations were oduced on the (111) cleavage plane of bismuth. Evidence that the s are dislocation sites was obtained from deformation and anneal studies and from density counts on intersecting boundaries.

539.2

08. MEASUREMENT OF DISLOCATION DENSITIES BY THE MBOT METHOD. L.F.Vassamillet and R.Smoluchowski.
appl. Phys., Vol. 30, No. 3, 418-26 (March, 1959).

The applicability of the Lambot X-ray technique to dislocation sity measurements is considered using several sample models of the dislocation array. The expression relating dislocation density of a random array to the angular misorientation of a particular set of lattice planes is derived. The dependence of broadening on the size of the diffracting area is found to satisfy this expression in the case of plastically deformed KCl. Limitations on the use of the method are discussed.

539.2

7509. DISLOCATION ETCH PITS AND POLYGONIZATION IN HIGH-PURITY COPPER. L.C.Lovell and J.H.Wernick.
J. appl. Phys., Vol. 30, No. 4(1), 590-2 (April, 1959).

A chemical etch was developed to reveal dislocations on the (111) plane of high-purity copper without prior decorating. By the use of this etch, it was observed that dislocation climb and polygonization did not occur after annealing bent single crystals near the melting point, in agreement with the X-ray results of other investigators.

539.2 : 537.531

7510. STRUCTURE OF QUENCHED AND IRRADIATED METALS.
R.E.Smallman and K.H.Westmacott.
J. appl. Phys., Vol. 30, No. 5, 603-16 (May, 1959).

The effect of introducing point defects into pure metals by (a) quenching and (b) irradiation was studied using the small-angle X-ray scatter technique. Scattering was obtained from both quenched copper and aluminium after appropriate ageing treatments, from α-irradiated copper after annealing, and from neutron-irradiated copper. The source of scattering was considered in each case. Direct observation of the scattering defects was obtained for the quenched, neutron-, and α-irradiated metals using thin film electron transmission microscopy. The quenched copper and aluminium contain dislocation loops of the order of a few hundred angstroms diameter formed by the condensation of vacancies, while the α-irradiated metal contains small cavities. Some additional electron microscopic studies of quenched silver and gold are also mentioned and the results discussed in relation to the mechanical and physical properties of quenched metals. No direct evidence has yet been found in neutron-irradiated copper (because of the difficulties in electropolishing), but the small-angle scattering when considered with mechanical property measurements strongly suggests the existence of small "regions" ~100 A diameter. Direct observation of "damage" in neutron-irradiated aluminium is observed, however, and shows the existence of dislocation loops, "jogged" dislocations, and "spiral" dislocations in agreement with theoretical predictions.

539.2 : 537.531

7511. SMALL ANGLE SCATTERING FROM DISLOCATIONS IN DEFORMED SINGLE CRYSTALS. A.K.Seeger.
J. appl. Phys., Vol. 30, No. 5, 629-37 (May, 1959).

It is shown that in spite of the occurrence of double Bragg scattering effects small angle scattering of X-rays from dislocations in cold-worked crystals should be observable, provided face-centred cubic crystals deformed in tension at low temperature are used. In stage II of the stress-strain curve the dislocation arrangement is essentially that of piled-up groups. The small angle scattering from such groups has been worked out, treating both the first-order (linear elastic theory) and second-order (nonlinear elastic theory) effects. The first-order effect dominates if the scattering vector g is normal to the glide-plane, whereas the second-order effect dominates if g lies in the glide-plane. If both effects can be observed, interesting information on the density and the arrangement of dislocations can be derived.

539.2

7512. ON THE KINETICS OF QUENCHED-IN LATTICE VACANCIES IN PLATINUM.
G.L.Bacchella, E.Germagnoli and S.Granata.
J. appl. Phys., Vol. 30, No. 5, 748-52 (May, 1959).

From quenching experiments the activation energy for vacancy formation in high purity platinum is found to be 1.20 ± 0.04 eV. Annealing behaviour after quenching is studied. First-order annealing is found when the concentration of quenched-in defects is low; the migration energy turns out to be 1.48 ± 0.08 eV. The annealing kinetics are not simple if the quenching temperature is high and the concentration of defects at least 10^{-4}.

539.2 : 548.73 : 537.531

ANALYSIS OF SMALL-ANGLE X-RAY SCATTERING FROM DEFORMED AND IRRADIATED METALS. See Abstr. 7042-8, 7554

539.2

7513. CAPTURE DIAMETER OF DISLOCATIONS IN LOW ANGLE GRAIN BOUNDARIES IN GERMANIUM. R.K.Mueller.
J. Phys. Chem. Solids, Vol. 8, 157-61, 164-5 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Measurements of conductance were made across tilt boundaries with misfit angles of 4°, 6° and 25° in n-type Ge. The capture rates of the boundaries were calculated, from which the capture diameters of the dislocations were obtained. The average capture diameter is 6.5 A. J.Franks

539.2

7514. SPACE-CHARGE-LIMITED CURRENTS AS A TECHNIQUE FOR THE STUDY OF IMPERFECTIONS IN PURE CRYSTALS. M.A.Lampert, A.Rose and R.W.Smith.
J. Phys. Chem. Solids, Vol. 8, 464-6, 484-5 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). A brief theoretical treatment is given of the current—voltage relationship for a solid with plane parallel geometry. As applied to the observed characteristic for a single crystal of CdS this theory indicates that there is a discrete defect level lying above the Fermi level and at a depth of 0.8 ± 0.05 eV below the bottom of the conduction band. The defect density is 3×10^{14} cm^{-3}. B.T.M.Willis

539.2 : 537.311.33

DISLOCATION PLANES IN SEMICONDUCTORS. See Abstr. 6925

539.2

7515. ISOCHRONAL ANNEALING OF VACANCIES IN ALUMINIUM. C.Panseri and T.Federighi.
Phil. Mag. (Eighth Ser.), Vol. 3, 1223-40 (Nov., 1958).

A study based on electrical resistivity measurements at liquid nitrogen temperature has been carried out on the isochronal annealing out of quenched-in vacancies in 99.995% Al. The process of annealing takes place in two stages; the first stage is centred at about room temperature and takes place at a lower temperature the higher the quenching temperature; also the observed migration energies (in the range 0.37 to 0.58 eV) and the mean number of jumps for annihilation (in the range 10^4 to 10^9) are very sensitive to the initial concentration of defects, that is to the quenching temperature. The second stage takes place at about 160° C and its amount increases largely with quenching temperature; its activation energy results in 1.3 ± 0.2 eV. The results have been interpreted as due principally to a clustering of vacancies (first stage) and subsequent dispersion of clusters by self-diffusion (second stage).

539.2

7516. COLOR CENTERS IN KI CONTAINING IMPURITY ELECTRON ACCEPTORS: KI:Tl. H.N.Hersh.
J. chem. Phys., Vol. 30, No. 3, 790-800 (March, 1959).

The optical and chemical properties of KI:Tl after X-raying and subsequent treatments at dry ice temperature or higher, or after colcration by electrolysis or chemical addition, were investigated. Analysis of the experimental data yields the following conclusions: (1) KI:Tl contains more electron traps than KI; (2) an electron-surplus centre (T) is formed when KI:Tl is F-bleached; (3) at concentrations of 10^{-2} mole percent Tl^+, metallic thallium, and not F-centres, is produced by additive or electrolytic coloration; (4) KI:Tl, KI, and other alkali halides undergo photochemical changes as a result of X-raying which are related to the production of V-centres. Arguments are presented which lead to the following deductions: (1) Tl^+ ions act as electron traps; (2) the greater stability of the T-centre relative to the F-centre is correlated to the greater electron-accepting nature of the impurity ion (whether it be Tl^+ or some other cation) relative to K^+, which renders the F, K, R, and M-centres unstable; (3) F-bleaching at room temperature of X-rayed crystals results in the formation of vacancy aggregates which are stable at room temperature via a transitory stage involving negative-ion vacancies; at low temperatures these aggregates cannot be "decomposed" by electrons because of the lack of thermal activation. Similar properties are exhibited by KBr:Tl. Many of the colour centre properties of KI:Tl should occur with other uni- and polyvalent cationic impurities, since they are most naturally explained on the basis of a greater electron affinity of the impurity ion than of K^+.

539.2

7517. NEW COLOR CENTERS IN KCl CRYSTALS. A.Halperin and M.Schlesinger.
J. chem. Phys., Vol. 30, No. 1, 339 (Jan., 1959).

KCl crystals coloured by X-rays at 80°K after ageing at 500° C for several hours show an absorption band peaking at ~4200 A which is stronger than the F band. This new band is bleached by irradiation at 4200 A or by heating to 250°K, but enhanced by light of the F wavelength (~ 5200 A). The pretreated crystals also have a greatly enhanced glow peak at 250°K. S.T.Henderson

539.2

7518. EFFECT OF DIVALENT CATIONS ON THE COAGULATIO OF F-CENTERS IN POTASSIUM CHLORIDE.
L.R.Watson and A.B.Scott.
J. chem. Phys., Vol. 30, No. 1, 342-3 (Jan., 1959).

The F-centre stability is enhanced by the presence of Ca^{++}, Sr^{++} and Ba^{++} ions and the formation of the colloid band by heating is inhibited due, it is suggested, to the reduced anion vacancy concentration. J.E.Caffy

539.2 : 535.377

7519. SYNTHESIS OF COLOUR CENTRES IN SILICA AND THEIR THERMOLUMINESCENCE. J.R.Hensler.
Nature (London), Vol. 183, 672-3 (March 7, 1959).

On exposure to γ-rays, colour centres were formed in Al doped SiO_2 powder, containing Li, Ag, Mg or P as a second impurity. The nature of the impurity centre is discussed. J.Franks

539.

7520. THE THEORY OF RADIATIONLESS TRANSITIONS IN AN F-CENTRE. V.A.Kovarskii.
Optika i Spektrosk., Vol. 5, No. 2, 222-4 (1958). In Russian.
English summary: PB 141047T-5, obtainable from Office of Technical Services, U.S. Dept. of Commerce, Washington, D.C., U.S.A.

The author extends to higher temperatures his own theory of radiationless transitions in F-centres in alkali-halide crystals, in which the potential energy of the electron—phonon interaction acts as a perturbation. He deduces a value of 5.55×10^{14} sec^{-1} for the frequency multiplier in the expression for the probability of thermal ionization of an F-centre in NaCl. This value agrees well with the experimental result obtained by Parfianovich (6.31×10^{14} sec^{-1}). I the study of thermal stimulation of non-activated NaCl the calculate values of the frequency multipliers for KCl and KI are given as 2.38×10^{14} and 3.45×10^{14} sec^{-1}.

539.2

7521. IRRADIATION EFFECTS IN SIMPLE ORGANIC SOLIDS. R.S.Alger, T.H.Anderson and L.A.Webb.
J. chem. Phys., Vol. 30, No. 3, 695-706 (March, 1959).

The colour centres and free radicals produced in irradiated solid alcohols, ketones, ethers, and other compounds were examine experimentally by means of optical absorption and EPR spectroscopy to obtain information regarding the products of ionization an the associated electronic processes. At liquid nitrogen temperatu these products of electron or X-ray bombardment are stable; however, the colour centres are photosensitive and can be bleached both optically and thermally. The alcohols also show an increase absorption near the characteristic u.v. bands. Removing the visibl colour centres increases the EPR h.f.s., but bleaching in the u.v. band markedly reduces or changes the h.f.s. In methanol and ethanol, free radicals are formed with good efficiency requiring about 18 and 12 eV per radical, respectively. Saturation concentrations of 2×10^{19} and 9×10^{19} spins per cm^3 were produced in aceto and methanol, respectively. The h.f.s. of ethanol and methanol indicate an alkyl hydrogen is missing from the radicals produced irradiating these materials. No sign of the atomic hydrogen doubl was observed at liquid nitrogen temperature. Support for the α– hypothesis was found in the h.f.s. displayed by the irradiated alco paraffins, ketones, and ethers.

539.21 : 537.311.

7522. GERMANIUM AND SILICON SURFACES. S.P.Wolsky.
J. Phys. Chem. Solids, Vol. 8, 114-16, 121-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Concerns the kinetics of the oxidation at room tempe ture of single crystal slices of germanium that have been bombar by positive ions after baking in vacuo. Preliminary measurement on silicon surfaces are also reported. J.Thew

539.

7523. RECOMBINATION CENTRES INTRODUCED IN GERMANIUM BY 2 MeV ELECTRONS. P.Baruch.
J. Phys. Chem. Solids, Vol. 8, 153-7, 164-5 (Jan., 1959). In Fren

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). Ge slices 1 mm thick were bombarded with 2 MeV electrons. The variation of lifetime and conductivity with numbe f incident electrons was measured. A recombination level is ntroduced at 0.18 eV below the conduction band. Recovery may be lue to the high mobility of interstitials produced. J.Franks

539.21 : 535.323

524. RADIATION-INDUCED CHANGES OF DIMENSIONS, NDEX OF REFRACTION, AND DISPERSION OF LITHIUM FLUORIDE. W.Primak.

Phys. Rev., Vol. 112, No. 4, 1075-83 (Nov. 15, 1958).

Deuteron, electron, gamma ray, and X-ray irradiated specimens vere examined by a photoelastic method and by interferometric nethods. In addition to the increase in physical dimensions, there vere found an increase in refractive index and an increase in dis-ersion, and these were measured. The results agree with the lassical dispersion formulae if it is assumed that the effects are aused by a change in the refractivity of the base material due to he introduction of vacancies and holes and a change in the refractivity ue to the F centres and the 450 centres, the size of the vacancies eing about that of the absent ions and the oscillator strength of the centres being near unity.

539.21

525. THERMAL AND RADIATION ANNEALING OF GERMANIUM. .W.Mackay, E.E.Klontz and G.W.Gobeli.

hys. Rev. Letters, Vol. 2, No. 4, 146-8 (Feb. 15, 1959).

It is found that about 50% of the defects produced by 1.10 Mev lectron irradiation of germanium at temperatures near 10°K can be nnealed either by heating to 80°K or by irradiating with electrons f energy less than the threshold for damage. The authors conclude hat a significant fraction of the defects in germanium at tempera-ures below 10°K are unstable and that these defects are most prob-bly close vacancy/interstitial pairs. R.Bullough

539.21

526. RADIATION EFFECTS IN SOLIDS. R.Smoluchowski.

adiation Research, Suppl. No. 1, 26-52 (1959). See Abstr. 5164 (1959).

An account is given of the theory of radiation damage by eutrons, protons, γ-rays, etc. Detailed consideration is then iven to experimental results obtained with metals, semiconductors, raphite and alkali halides. Surface reactions are also considered. J.Thewlis

539.21 : 535.343

INFRARED ABSORPTION IN NEUTRON IRRADIATED SILICON. ee Abstr. 6731

539.21 : 538.27

POTENTIALITIES AND LIMITATIONS OF THE PARAMAGNETIC ESONANCE METHOD IN RADIATION RESEARCH. See Abstr. 7189

STRUCTURE OF SOLIDS

539.211

527. INVESTIGATION OF AN ALLOY SURFACE WITH THE IELD EMISSION MICROSCOPE. R.C.Bradley and L.A.D'Asaro.

appl. Phys., Vol. 30, No. 2, 226-33 (Feb., 1959).

The field emission microscope was used to investigate the rface of an alloy of a few per cent zirconium in molybdenum. The eld emission patterns indicate that a high-temperature flash 000°K) reduces the surface concentration of zirconium to zero. bsequent heat treatment at 1000°K brings Zr to the emitting sur-ce where it adsorbs preferentially in small clusters on the lattice eps of the {100} planes. These clusters are easily observed cause of their high electron emission. Their emission character-ics reveal them to be smooth layers of low work function .94 ± 0.01 eV) rather than protruding crystallites. When the bulk ncentration of zirconium in the alloy is increased from 1 to 5% e emission patterns change markedly but there is little effect on e adsorption characteristics of the surface. Surface migration, sorption, and bulk diffusion of zirconium were found to proceed pidly at temperatures above 1200°K, 1500°K and 2000°K, respect-ly. Measurements of activation energies for surface migration d desorption gave 2.7 ± 0.3 and 4.15 ± 0.15 eV, respectively.

539.211

28. SOME SURFACE PROPERTIES OF SILICON-CARBIDE RYSTALS. J.A.Dillon, Jr, R.E.Schlier and H.E.Farnsworth.

appl. Phys., Vol. 30, No. 5, 675-9 (May, 1959).

The work functions of a number of commercial-grade silicon-rbide single crystals were obtained in high vacuum ($p < 10^9$ mm Hg). Low-energy electron-diffraction studies were also made for one of these samples. Surfaces cleaned by argon-ion bombardment and annealing appeared to contain an excess of carbon. Heating for long periods of time at 1000°C also appeared to produce surfaces which were nonstoichiometric. Oxygen was adsorbed at room temperature on the ion-bombardment cleaned surfaces with a sticking coefficient of the order of 0.01. Differences in adsorption properties were noted which were probably associated with asymmetry in atomic species on different crystal faces. Work-function values on opposite faces of any crystal were the same. Hydrogen exposure resulted in work-function decreases only in the presence of a heated filament. Under similar conditions of ion bombardment and high-temperature heating, the SiC surfaces appeared to be more stable than those of silicon crystals.

539.211

7529. STRESS WAVES AND FRACTURE SURFACES. E.H.Andrews.

J. appl. Phys., Vol. 30, No. 5, 740-3 (May, 1959).

Surface markings observed in the brittle fracture of certain frozen rubbers display striking wave-like characteristics. They have been identified as "Wallner" lines, caused by the interaction of the fracture front with stress waves emanating from the region of the fracture front itself. These oscillations are possibly caused by the supply of excess energy to the fracture tip. A value of approximately 1 : 2 is obtained for the ratio of fracture velocity to wave velocity.

539.211 : 541.183

7530. STRUCTURE AND ADSORPTION CHARACTERISTICS OF CLEAN SURFACES OF GERMANIUM AND SILICON. R.E.Schlier and H.E.Farnsworth.

J. chem. Phys., Vol. 30, No. 4, 917-26 (April, 1959).

Low-energy electron diffraction patterns obtained from atomically clean germanium surfaces contained half-integral order beams in (110) azimuths for both (100) and (110) surfaces and in all azimuths for the (111) surface. These results are considered to be due to displacements of surface atoms from their normal bulk lattice positions in the surface plane. Adsorption of oxygen on all of these surfaces extinguished all of the diffraction beams which were not integral-order. In addition to the normal surface lattice spacings of clean (111) and (100) surfaces of silicon, there were surface structures with larger spacings, most of which depended on the conditions of ion bombardment and/or subsequent heat treatment. Two such structures have been observed for the (100) surface of silicon; one is a double-spaced lattice in the (110) azimuth, similar to that for germanium, and the other has a spacing about 8% greater than that of normal silicon and was obtained only after radiation quenching of the crystal from 1000°C. Two large-spaced structures were observed for the (111) surface. All of these structures were extinguished by exposure to oxygen. Evidence is presented which indicates that these structures were not due to contamination but to the silicon itself. The method of determining the kinetics of gas adsorption from the low-energy electron diffraction beams is outlined and the calculations of the fractional coverage and sticking probability are presented for oxygen. For silicon crystals, the calculations of surface coverages and sticking coefficients for oxygen were found to depend on the preceding treatments of the crystals. The rate of adsorption of oxygen was proportional to the pressure, at least for pressures below 10^{-6} mm Hg, and depended on the preceding treatments of the crystals. After oxygen adsorption, the clean germanium surface could be regenerated by heating at 500°C for 30 min and for silicon it was regenerated by heating at 900°C for a few minutes. A comparison with results of other observers is given.

539.211 : 535.43

QUALITY OF POLISHED OPTICAL SURFACES AS CHARACTERIZED BY DEPTH AND EXTENT OF IRREGULARITIES. See Abstr.6796

539.213 : 532.61.08

SURFACE TENSION AND DENSITY MEASUREMENTS ON MOLTEN GLASSES IN THE $CaO. Al_2O_3. SiO_2$ SYSTEM. See Abstr. 6580

539.213 : 532.7

MOBILITY OF MOLECULES IN LIQUIDS NEAR THE GLASS TEMPERATURE. See Abstr. 6587

539.213.2

7531. EXPERIMENTAL METHOD FOR DEVELOPING MINUTE FLAW PATTERNS IN GLASS. W.C.Levengood.

J. appl. Phys., Vol. 30, No. 3, 378-86 (March, 1959).

A new chemical etching technique was used to study minute flaw patterns in glass. The etched structure disclosed that the minute defects react to the chemical treatment in a different manner than ordinary fissures. Flaw patterns formed at the tips of slow-moving internal cracks were analogous to dislocation phenomena in crystals. Oriented and repeating flaw groupings were observed in various types of glass. These patterns are produced above the "strain point" and were shown to be influenced by permanently induced stresses and internal homogeneity. Fracturing by localized stresses created flaw patterns radiating from the point of origin with shapes similar in appearance to shock wave phenomena. The impact breaking strength of glass containers was directly influenced by the number of flaws. The flaw distribution decreased rapidly with decreasing diameter of glass fibres.

539.217

7532. SELF-DIFFUSION IN SILVER DURING PLASTIC DEFORMATION IN EXTENSION AND COMPRESSION.

J.B.Darby, Jr, C.T.Tomizuka and R.W.Balluffi.

J. appl. Phys., Vol. 30, No. 1, 104-12 (Jan., 1959).

Self-diffusion of Ag^{110} in silver single crystals subjected to simultaneous deformation at 800° and 900°C was studied using the sectioning technique. The crystals were orientated for duplex slip and were deformed in extension and compression at constant strain rates in the range 1 to 28×10^{-5} sec^{-1}. Total strains as large as 0.33 were attained. Recrystallization occurred in the initially single crystal specimens during diffusion-deformation under all conditions except tension at 800°C. The effect of straining on the rate of diffusion was found to be small in all cases. The straining changed the diffusivities by less than 50%, and it is concluded that the observed changes were probably within the experimental error. The results indicate that any increases in diffusion rate due to the generation of point defects or short-circuiting paths during deformation were small. These conclusions are shown to be consistent with other experiments involving these phenomena.

539.217

7533. DIFFUSION OF IMPURITIES INTO EVAPORATING SILICON. R.L.Batdorf and F.M.Smits.

J. appl. Phys., Vol. 30, No. 2, 259-64 (Feb., 1959).

Steady-state impurity distributions are produced when impurities are diffused into a piece of silicon, the surface of which is evaporating. The moving boundary condition results under steady-state in an exponential impurity distribution. The silicon evaporation rate was determined for temperatures between 1200 and 1325°C from weight loss measurements. No difference in the evaporation rate from various crystallographic planes could be observed from the diffusion technique but flat-bottomed etch pits which formed on surfaces closely orientated to the (111) plane indicated that this plane is probably the most stable. Single diffusions as well as simultaneous double diffusions of phosphorus and gallium into silicon were studied.

539.217

7534. ON THE EFFECT OF NONEQUILIBRIUM VACANCIES ON THE KINETICS OF KIRKENDALL DIFFUSION.

H.Fara and R.W.Balluffi.

J. appl. Phys., Vol. 30, No. 3, 325-9 (March, 1959).

Vacancy diffusion models which predict parabolic diffusion-penetration kinetics implicitly assume that vacancy equilibrium is maintained everywhere. However, a nonequilibrium vacancy distribution is generally established by the pumping action of the chemical gradient in the Kirkendall effect. A more general diffusion model is, therefore, developed in which vacancies are not necessarily maintained in equilibrium. The behaviour of the model is then investigated and nonparabolic kinetics are found. However, the kinetics approach those of the equilibrium model as either the vacancy lifetime approaches zero or as the diffusion time becomes very long. The applicability of the equilibrium model, therefore, depends upon the particular system and diffusion time. The results are compared with experiment, and it is concluded that nonparabolic effects are probably of little importance in usual face-centred-cubic metallic systems by the time diffusion measurements are made by conventional sectioning methods, i.e., when $Dt > \sim 10^{-5}$ cm^2.

539.217

7535. DIFFUSION OF INTERSTITIAL SOLUTES IN THE GROUP V TRANSITION METALS. R.W.Powers and M.V.Doyle.

J. appl. Phys., Vol. 30, No. 4(1), 514-24 (April, 1959).

Mechanical relaxation measurements are used extensively to obtain information on the diffusion rate of interstitial solute atoms in body-centred cubic metals. Such studies have been stimulated by a model, developed by Snoek (1941), which yielded a relationship between a relaxation time, an experimental parameter, and the diffusion coefficient of the solute atom. Although Snoek's model was confirmed very well for solid solutions of carbon or nitrogen in α-iron, a number of anomalies were observed when relaxation studies were extended to the group V transition metals. An extensive experimental study has been made of the factors that influence relaxation times. The anomalous behaviour of the group VA metal can be accommodated within the framework of Snoek's model by taking account of the specific nature of solid solutions based on these metals. Diffusion data obtained by a variety of relaxation techniques are presented for oxygen, nitrogen, and carbon in vana ium, niobium (columbium), and tantalum. These data are in agreement with those obtained by the more conventional concentration gradient techniques in the few instances where such information is available. The pattern of activation energies suggest that lattice strain considerations alone are insufficient to explain the activatio process involved in interstitial diffusion.

539.2

7536. INFLUENCE OF SOLUTES ON SELF-DIFFUSION IN THE FACE-CENTERED CUBIC LATTICE. H.Reiss.

Phys. Rev., Vol. 113, No. 6, 1445-61 (March 15, 1959).

A theory is given for the influence of substitutional solutes on self-diffusion in the face-centred cubic lattice. The theory is limited to cases in which the concentration of solute is low enough so that only one solute atom at a time can interact with a given tracer atom. Two different kinds of approximation are employed, one in which the processes of association and dissociation of vacancies and solute atoms do not themselves contribute to transport, and one in which they do but the frequency of exchange betwe solute and vacancy is considered to be infinite. From data on the diffusion coefficient of the solute as well as on the self-diffusion coefficient in its dependence on solute concentration the ratio of th frequency with which a vacancy exchanges with a solute atom to th with which it exchanges with a host atom in the first coordination shell of a solute can be estimated. This ratio appears to lie betw 0.1 and 0.5 for solutes in silver which increase self-diffusion and for which experimental data are available. An analysis is given which shows that a good estimate of the influence of a given solute on self-diffusion can be made when only the diffusion coefficient o that solute is known. Finally the effect which Pd in silver has on the self-diffusion coefficient (Pd reduces the self-diffusion coefficient) is calculated on the basis of the theory. Agreement between theory and experiment is satisfactory.

539.217 : 53

LIQUID FLOW THROUGH POROUS MEDIA. See Abstr. 6579

539.2

7537. DENSIFICATION DURING SINTERING IN THE PRESENC OF A LIQUID PHASE. I. THEORY. W.D.Kingery.

J. appl. Phys., Vol. 30, No. 3, 301-6 (March, 1959).

The driving force leading to densification during sintering in the presence of a liquid phase and the material transport phenome are analysed and relationships for the densification rate during th rearrangement process, the solution—precipitation process, and the final coalescence process are determined. These relationship allow an experimental determination of the mechanism of sinterin in the presence of a liquid phase on the basis of the time, particle size and temperature dependence of the densification rate. In addition, they allow direct calculations of densification rates to be made for certain simple systems for which property data are available.

539.2

7538. DENSIFICATION DURING SINTERING IN THE PRESENC OF A LIQUID PHASE. II. EXPERIMENTAL.

W.D.Kingery and M.D.Narasimhan.

J. appl. Phys., Vol. 30, No. 3, 307-10 (March, 1959).

For Pt I, see preceding abstract. Experimental measuremen of the densification rate and microstructure changes taking place during sintering of the iron—copper system, which is typical of th systems showing spheroidal grain development, indicate that in th system the rate of densification during liquid phase sintering is controlled by diffusion through a liquid film between particles. Dependence of the sintering rate on time, particle size and tempe ture are in agreement with theoretical predictions. A theoretical estimation of the sintering rate is in good agreement with experimental measurements.

539.219 : 532.77

PROPERTIES OF SOLID AND LIQUID SOLUTIONS OF ARGON AND KRYPTON. See Abstr. 6600

539.23 : 539.1.07

7539. A METHOD FOR THE PREPARATION OF VERY THIN FOILS. E.Kashy, R.R.Perry and J.R.Risser.
Nuclear Instrum., Vol. 4, No. 3, 167-70 (April, 1959).

A method is outlined for the preparation of self-supporting carbon foils of thicknesses ranging between 4 and 30 $\mu g/cm^2$, and of areas ranging between 0.25 and 1 cm^2. The essential features of the method are such that its application is not restricted to carbon.

539.231

7540. SPUTTERING YIELD OF GERMANIUM IN RARE GASES.
N.Laegreid, G.Wehner and B.Meckel.
J. appl. Phys., Vol. 30, No. 3, 374-7 (March, 1959).

Sputtering yields of germanium bombarded by Xe^+, Kr^+, Ne^+, and He^+-ions under normal incidence at energies up to 400 eV have been determined. Yield versus ion energy curves consist of three parts: (1) a low-energy tail (possibly caused by a process of step-wise sputtering); (2) a region in which yield rises proportionally with ion energy, and above ion velocities of $\sim 3 \times 10^6$ cm/sec; (3) a region n which the yield rises less than proportionally with ion energy. The slope in the proportional region is largely determined by the energy ransfer factor, $\eta = 4m_1m_2/(m_1 + m_2)^2$. Surprisingly, the "cut in" nergies do not follow $V_0 \sim H/\eta$ (H = heat of sublimation) but are ound to be much lower than expected for the lighter gases. The mpirical result, $V_0 \sim H(m_1)^{1/2}/\eta$ (m_1 = atomic weight of ion), is not et understood.

539.231 : 539.18

541. LOW-ENERGY SPUTTERING YIELDS IN Hg.
.K.Wehner.
hys. Rev., Vol. 112, No. 4, 1120-4 (Nov. 15, 1958).

For previous work, see Abstr. 7540(1958). Further data on puttering yields for normally incident Hg^+-ion bombardment in the nergy range of 50 to 400 eV have been collected. Experimental ata are used to determine the influence of atomic weight and heat f sublimation of the target material and to establish an empirical puttering relation. Results provide strong support for a picture of puttering which might be termed "playing three-dimensional illiards with atoms." The degree of filling of the inner shells, specially the d-shells, determines how closely collisions approximte hard-sphere collisions. Energy is transferred most efficiently metals with completely filled d-shells. Accordingly, Cu, Ag, and have the highest sputtering yields. Results for Hg^+-ion ombardment support theories developed by Langberg and by lsbee, but disagree with a theory published by Henschke. Contions may be different, however, for the case of bombardment ith light ions such as hydrogen or helium. The sputtering yields alloys do not seem to differ substantially from those of their ain constituents.

539.231 : 523.51

SPUTTERING AS IT IS RELATED TO HYPERBOLIC ETEORITES. See Abstr. 6452

539.234

42. THE STRUCTURE AND DENSITY OF IRON FILMS ORMED BY THERMAL EVAPORATION.
S.Heavens, M.M.Brown and V.Hinton.
cuum, Vol. 9, No. 1, 17-20 (March, 1959).

The densities were determined of iron films of thickness 0-1600 A deposited on the cleavage faces of rocksalt crystals intained at 470°C. The films are monocrystalline, as shown by ctron diffraction, and appear continuous when examined in the ctron microscope. The values obtained for the densities are nd not to differ significantly from that for the bulk metal.

539.234

43. ADHESION OF EVAPORATED METAL FILMS.
Schossberger and K.D.Franson.
cuum, Vol. 9, No. 1, 28-35 (March, 1959).

An abrasion—resistivity test was developed to study the esion of vacuum-deposited aluminium films on glass surfaces. e test consists of measuring the electrical resistance of the metal n during abrasion by a stream of fine silicon carbide particles. analysis is given of the anticipated test results on homogeneous nonhomogeneous metal films and on effects near the interface. ferences in the plating and annealing conditions of evaporated minium films were detected by the abrasion—resistivity test. Poorest adhesion was found on platings made on unclean surfaces and platings made at a slow rate of evaporation of the metal. The optimum substrate temperature for good adhesion was determined to be 175°C. Annealing of the aluminium film resulted in formation of a surface oxide layer and development of an interlayer compound at the interface.

539.27 : 539.19

7544. NOTE ON THE OBSERVATION OF MOLECULES BY FIELD EMISSION MICROSCOPY. R.J.Hill and P.W.M.Jacobs.
J. chem. Phys., Vol. 30, No. 3, 853-4 (March, 1959).

Points out that "spotted" patterns in field emission microscopes may be due to the effect of carbonaceous material derived from the pump oil being deposited on the tip of the emitter. Depending on the amount of oxygen present, either oxygen or carbon patterns will result. This indicates that claims for the resolution of single molecules of oxygen should be treated with reserve. T.Mulvey

539.27

7545. SPACING ANOMALY IN ELECTRON MICROSCOPE IMAGES OF CRYSTAL LATTICES. H.Hashimoto and H.Yotsumoto.
Nature (London), Vol. 183, 1001-2 (April 4, 1959).

Electron micrographs of metal phthalocyanine crystals often show anomalous line spacings. These are probably dynamical effects produced by electron scattering from bent crystals which show thickness variations, and not necessarily by irregularities in the crystal lattice spacing. R.Reed

539.27

7546. SURFACE-STRUCTURE AND WORK-FUNCTION DETERMINATIONS FOR SILICON CRYSTALS.
H.E.Farnsworth, R.E.Schlier and J.A.Dillon, Jr.
J. Phys. Chem. Solids, Vol. 8, 116-18, 121-2 (Jan., 1959).

Rochester Semiconductors Conference Paper (see Abstr. 4569/1959). The surface structure was examined by electron diffraction after various treatments (e.g. annealing or radiation quenching after ion bombardment) had been applied. An unidentified material (or materials) was observed having much larger spacings than Si. The work functions were independent of the differences in surface structure. Observations were made on the Fermi level and on the thermal etching of the crystals. J.Thewlis

ELASTICITY . STRENGTH . RHEOLOGY

539.31

7547. INTERFACE COUPLES IN CRYSTALS.
F.A.McClintock, P.A.André, K.R.Schwerdt and R.E.Stoeckly.
Nature (London), Vol. 182, 652-3 (Sept. 6, 1958).

A rough estimate is made of the order of magnitude of gradients of strain which might give rise to couples across elementary surfaces drawn in a material, sufficient to cast doubt on the usual proof that the stress tensor is symmetrical. J.G.Oldroyd

539.32 : 537.228.1

7548. EQUATIONS FOR TRANSFORMING ELASTIC AND PIEZO-ELECTRIC CONSTANTS OF CRYSTALS. R.F.S.Hearmon.
Acta cryst., Vol. 10, Pt 2, 121-4 (Feb., 1957).

With the aid of tensor notation and methods, the equations for transforming the stiffness and compliance constants of crystals from one set of orthogonal axes to another are presented in compact tabular form. A similar treatment is also given for the piezoelectric constants.

539.32 : 621.372.412

7549. THE ANELASTICITY OF NATURAL AND SYNTHETIC QUARTZ AT LOW TEMPERATURES. J.C.King.
Bell Syst. tech. J., Vol. 38, No. 2, 573-602 (March, 1959).

Certain imperfections in alpha-quartz are found to introduce anelastic absorption at low temperatures in crystal resonators. For a shear wave of 5 Mc/s, absorption peaks are observed at approximately 20° and 50°K in unirradiated samples. X-irradiation effects a lowering of the amplitude of the 50°K absorption, while a new absorption is introduced at 100°K. The results of acoustic absorption measurements on a number of selected samples of synthetic quartz resonators suggest that, whereas the 50°K absorption is attributable to excess oxygen, the 100°K defect involves aluminium which is present substitutionally in the crystal structure. X-irradiation-induced lowering of the resonant frequency of crystal resonators is clearly the result of a lowering of the elastic modulus associated with the 100° K anelastic absorption.

539.32

7550. DISLOCATION CONTRIBUTION TO THE TEMPERATURE DEPENDENCE OF THE INTERNAL FRICTION AND YOUNG'S MODULUS OF COPPER. D.O.Thompson and D.K.Holmes.

J. appl. Phys., Vol. 30, No. 4(1), 525-41 (April, 1959).

A study of the amplitude-independent internal friction and Young's modulus in copper from 14° K to room temperature, both before and after neutron irradiation, indicates that there are two dislocation components in these quantities. These have been tentatively identified as a relaxation component studied in detail theoretically by Seeger and a background component which appears to be characteristic of Koehler's bowing mechanism. It is felt that these two components are probably quite intimately related, for the relaxation processes, and the activation energy of the background process is about twice the kink energy obtained from Seeger's theory. Moreover, the Bordoni, or relaxation spectrum, is shown to be considerably more complex than has been previously indicated in that there appear to be at least four principal relaxations. As a result of the analysis attempted in the present work, it appears that the more obvious difficulties of Seeger's theoretical treatment are alleviated.

539.32

7551. ELASTIC MODULI OF SINGLE-CRYSTAL GALLIUM ARSENIDE. T.B.Bateman, H.J.McSkimin and J.M.Whelan.

J. appl. Phys., Vol. 30, No. 4(1), 544-5 (April, 1959).

Velocities of propagation of high-frequency ultrasonic waves and the adiabatic elastic moduli for single-crystal gallium arsenide are reported. Data at 25° C were obtained in the range of 20-180 Mc/s. The elastic moduli based on a density of 5.307 g/cm^3 in units of 10^{12} dynes/cm^2 are $c_{11} = 1.188 \pm 0.14\%$; $c_{12} = 0.538 \pm 0.36\%$; $c_{44} = 0.5940 \pm 0.14\%$.

539.32

7552. ELASTIC CONSTANTS OF SODIUM IODIDE FROM 180° K TO 300° K. R.Dalven and C.W.Garland.

J. chem. Phys., Vol. 30, No. 1, 346-7 (Jan., 1959).

The three independent adiabatic elastic constants were measured by the ultrasonic pulse-echo technique, and by extrapolation a Debye characteristic temperature at 0° K of 167° K was obtained. The Cauchy relation could not be verified due to inaccuracy of the measurements.

J.E.Caffyn

539.32 : 534.133

MECHANICAL RESONANCE DISPERSION IN SINGLE CRYSTALS. See Abstr. 6619

539.32 : 534.22

MEASUREMENT OF ULTRASONIC WAVE VELOCITIES AND ELASTIC MODULI FOR SMALL SOLID SPECIMENS AT HIGH TEMPERATURES. See Abstr. 6630

539.374 : 534.21

PROPAGATION OF PLASTIC WAVES IN SOLIDS. See Abstr. 6627

539.374 : 534.23

7553. PRESSURE DEPENDENCE OF THE VISCOELASTIC BEHAVIOR OF POLYISOBUTYLENE. H.Singh and A.W.Nolle.

J. appl. Phys., Vol. 30, No. 3, 337-41 (March, 1959).

The absorption of 4 Mc/s ultrasonic waves in polyisobutylene is measured as a function of temperature for various pressures. The extreme limits of these variables are 1 to 1400 atm and −20° to 80° C, respectively. Approximate measurements of propagation velocity are also obtained. Pulse reflection apparatus was used. A magnetically actuated holder places the sample in the signal path or removes it. Pressure—volume data were obtained for polyisobutylene at 30° C by means of a capillary dilatometer fitted with electrical contacts, in which the sample is placed with mercury. The expected behaviour of viscoelastic relaxation times with temperature and pressure is computed by adapting a theory due to Bueche. With additional assumptions concerning the compressibility, the theory gives a shift of the constant-frequency absorption maximum of 0.025 deg. C/atm, in approximate agreement with experiment.

539.386 : 534.2

SCATTERING OF SHEAR WAVES BY SPHERICAL OBSTACLES. See Abstr. 6622

539.4.016.2 : 537.5

7554. DOUBLE BRAGG X-RAY SCATTERING FROM COLD-WORKED METALS. W.T.Ogier, R.L.Wild and J.C.Nickel.

J. appl. Phys., Vol. 30, No. 3, 408-12 (March, 1959).

The average small angle double Bragg scattering from moder ately cold-worked polycrystalline metals has been calculated igno extinction. The predicted scattering is of the correct order of ma nitude. Tests involving dependence on grain size prior to cold wo density of the metal, degree of plastic deformation, and anisotropy have been made and appear to agree with the calculation.

539.42 : 539.2

7555. TIME DEPENDENCE OF MECHANICAL BREAKDOWN IN BUNDLES OF FIBERS. V. FIBERS OF CLASS A-2. B.D.Colem

J. appl. Phys., Vol. 30, No. 5, 720-4 (May, 1959).

For Pt IV see Abstr. 882 (1959). The theory of mechanical breakdown in bundles of Class A-2 fibres, whose strength depends on the speed of measurement, is used to find the conditions under which time-dependence effects can be neglected in calculations of relationships between the strength of bundles and the strength of their constituent filaments. (The classical theories of the strengt of bundles do not consider time-dependence.) Tables and graphs are presented which give the ratio, ϵ_A, of the strength of an infini ideal bundle to the mean strength of its filaments as a function of coefficient of variation, $\sigma_1/E_1\{f^*\}$, in the strength of the filaments. It is shown that, under certain limiting conditions, ϵ_A for an infini bundle of Class A-2 fibres is the same as it would be for an infini bundle of classical fibres with an equal value of $\sigma_1/E_1\{f^*\}$, and a numerical investigation is made of the rapidity with which this limiting behaviour is approached.

539.43

7556. IMPROVEMENT OF THE FATIGUE STRENGTH OF NOTCHED SPECIMENS BY ARTIFICIALLY INDUCED RESIDUAL STRESSES. T.R.Gurney.

Nature (London), Vol. 183, 883-4 (March 28, 1959).

Flat steel strips, each with a single short longitudinal stiffen gusset fillet welded centrally on each face and opposite each other were used. One batch was used as a control, while another batch was compressed locally between dies to induce residual stresses. All specimens were tested under an alternating axial load and it was found that the control batch had an upper limit stress of 6.5 t.s.i. for an endurance of 2×10^6 c/s. while for the compress specimens it was 11 t.s.i. Also the two stress—endurance curve converged to 18 t.s.i., the yield strength of the material.

A.E.

539.

7557. HIGH-TEMPERATURE MECHANICAL PROPERTIES O GRAPHITE. I. CREEP IN COMPRESSION.

P.Wagner and A.R.Driesner.

J. appl. Phys., Vol. 30, No. 2, 148-51 (Feb., 1959).

Measurements were made on the steady-state rates of compressive creep of graphite in the temperature range 2270 to 278 Creep to failure was observed to occur in one of two ways: thre out of seventeen samples exhibited a third stage of creep before failure occurred, the remaining fourteen samples failed in a ma analogous to that observed for graphite in tension, that is fractu without the appearance of a third stage. All the latter type cree data are correlated by a classical rate equation of the form: rate = $K(\sigma/\sigma_B)^n \exp(-E/RT)$.

539

7558. HIGH-TEMPERATURE PROPERTIES OF GRAPHITE. II. CREEP IN TENSION. P.Wagner, A.R.Driesner and L.A.Ha

J. appl. Phys., Vol. 30, No. 2, 152-4 (Feb., 1959).

For Pt I, see preceding abstract. Measurements were ma the steady-state creep rates of graphite in tension in the tempe ture range 2270 to 3270° K. Moulded, extruded, and uranium "loaded" graphites were used in the course of investigation. T results covering the range of steady-state creep 10^{-7} to 10^{-4} cm/cm-sec are in accord with published data. In addition, the tensile steady-state creep data are correlated by a classical r equation of the form: rate = $f(U)(\sigma/\sigma_B)^n \exp(-E/RT)$, where f(is a function of the uranium concentration in the graphite.

53

7559. THEORY OF CREEP LIMITED BY SELF-DIFFUSION

R.W.Christy.

J. appl. Phys., Vol. 30, No. 5, 760-4 (May, 1959).

A theory of steady-state creep at high temperature and st is based on the climb of dislocations limited by the diffusion of vacancies from them. The creep rate is found to be approximately $(MnL^3)D_0 \exp[-(W + E + U - \Delta W)/kT]$, where M is the number of dislocation sources per unit volume, n is the number of dislocations of length L per unit area, and $D_0 \exp(-W/kT)$ is the coefficient of self-diffusion. The number of jogs in the dislocations is determined by U, and E is an activation energy for formation of vacancies, due o relaxation of the lattice. The reduction in vacancy formation energy near a dislocation ΔW is estimated from the interaction energy of the climbing dislocations. A comparison of experimental lata for Zn and AgBr suggests that E is a significant contribution to he activation energy for ionic crystals but not for metals. The pre- licted increase in vacancy concentration during creep is too small o give observable effects. It is concluded that any observed en- ancement of diffusivity during creep is due to increased mobility of efects.

539.434

7560. AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF VACANCY AND F-CENTRE CONCENTRATIONS ON THE TRAN- IENT CREEP [AT ROOM TEMPERATURE] OF SODIUM CHLORIDE INGLE CRYSTALS. R.A.Lad and F.I.Metz.

. Mech. Phys. Solids, Vol. 4, No. 1, 28-37 (Oct., 1955).

Under a load of 1200 g/mm², logarithmic creep behaviour was ound for both annealed and quenched crystals before or after rradiation. Irradiation with 50 kV X-rays was found to have a narked effect on both initial deformation and subsequent creep, ausing an initial softening followed by a hardening as irradiation is ontinued. The behaviour after irradiation can be explained on the asis of the changes in vacancy concentration and distribution which accompany F-centre formation. Experiments in which the vacancy concentration was changed by quenching from various temperatures indicate that the creep rate may depend in a simple way on the number of vacancies.

539.58 : 536.424.1

COMPRESSION AND THE α—β PHASE TRANSITION OF PLUTONIUM. See Abstr. 6841

539.61

7561. EFFECT OF OXYGEN ON THE BONDING OF GOLD TO FUSED SILICA. D.G.Moore and H.R.Thornton.

J. Res. Nat. Bur. Stand., Vol. 62, No. 3, 127-35 (March, 1959).

Gold pellets were melted on plaques of polished fused silica in vacuum and then heated for 15 min at 1100°C under different oxygen pressures. The force required at room temperature to shear the solidified pellets from the silica surface was found to vary from zero for gold melted in vacuum to 725 lb/in² for gold melted under an oxygen pressure of 150 mm. In all cases where bond developed, fracture occurred in the silica rather than at the gold—silica interface. Silica plaques with pellets bonded to them by treatment in oxygen showed no measurable strain when examined with a polarograph, suggesting that the gold had yielded as the specimen cooled. Tests using Au^{198} as a tracer indicated that gold diffused into the silica lattice at high oxygen pressure but that no diffusion occurred during vacuum heating. Observations made on molten droplets showed no correlation between the contact angles in air and vacuum and the apparent shear strengths. A possible explanation is included to account for this lack of agreement with theory.

PHYSICAL CHEMISTRY

PHASE EQUILIBRIUM

CHEMICAL REACTIONS

541.123 : 536.422

62. THE SUBLIMATION PRESSURES OF THE SYSTEMS Cl + $NaCl.2H_2O$ and $CaCl_2.H_2O$ + $CaCl_2.2H_2O$. J.Sommer.

angew. Phys., Vol. 10, No. 11, 517-21 (Nov., 1958). In German.

The apparatus and method of measuring the pressures are scribed. Plots of log p against I/T are linear for both systems the temperature range −10° to −60°C and parallel to the (similar) ot for ice. These salt hydrate systems thus behave as two-mponent systems of which one component exerts no noticeable pour pressure. W.Good

541.124

63. UNIMOLECULAR DECOMPOSITION OF CHEMICALLY TIVATED SEC-BUTYL RADICALS FROM H ATOMS PLUS S-BUTENE-2. B.S.Rabinovitch and R.W.Diesen.

chem. Phys., Vol. 30, No. 3, 735-47 (March, 1959).

Chemically activated sec-butyl radicals were produced at nperatures between −103° and 25°C by reaction of H atoms with -butene-2. H atoms were allowed to effuse through a molecular t into a spherical reactor containing olefine at low pressure. e system resembles the Polanyi diffusion flame, and some solu- ns for the radial distribution functions of the species involved given. Disproportionation-recombination ratios for sec-butyl icals and for methyl plus butyl radicals, were measured as 0.94 0.30 respectively. The ratios of stabilization v. decomposition C—C rupture for the energized butyl radicals were measured as nction of pressure and temperature. Hydrogen and helium were used as inert gases. k_a the observed rate constant for decom- ition is $\sim 10^7$ sec^{-1}. The energized butyl radicals are closely noenergetic. The unimolecular decomposition behaviour is npared with theory wherein expressions due to Marcus (Abstr. 3, 3956/1952) are employed. All vibrational degrees of freedom be taken as active.

541.124 : 533.72

THE CONSERVATION EQUATIONS FOR INDEPENDENT EXISTENT CONTINUA AND FOR MULTICOMPONENT ACTING GAS MIXTURES. See Abstr. 6617.

541.126 : 532.5

7564. INITIATION OF DETONATIONS.

H.W.Hubbard and M.H.Johnson.

J. appl. Phys., Vol. 30, No. 5, 765-9 (May, 1959).

In order to study the initiation of detonation waves, the time dependent one-dimensional hydrodynamic equations are numerically integrated for several initial conditions. In all the cases treated, the hydrodynamic motion and the release of chemical energy are practically independent as a consequence of the extreme temperature sensitivity of the reaction rate. At first the chemical energy is released so slowly that it has no effect on the hydrodynamic motion. Thereafter the reaction proceeds so rapidly that the burning is not influenced by the hydrodynamic motion. A simple criterion is established to determine whether or not detonation will result from given initial conditions of pressure and temperature. This criterion is applied to determine how the detonability depends upon the duration of the initial pressure pulse and upon the initial temperature distribution.

541.127

7565. KINETICS OF THE THERMAL DECOMPOSITION OF DIMETHYLMERCURY. I. CYCLOPENTANE INHIBITION.

M.E.Russell and R.B.Bernstein.

J. chem. Phys., Vol. 30, No. 3, 607-12 (March, 1959).

The kinetics of the pyrolysis of gaseous dimethylmercury has been studied in the presence and absence of cyclopentane inhibitor from 290-375°C for the inhibited and 265-350°C for the unhibited reactions. The decomposition in excess cyclopentane is first order, with methane the major product (accounting for > 95% of the carbon). Rate constants are dependent upon the ratio of dimethylmercury (DMM) to cyclopentane and upon total pressure. The constant for DMM loss is: $k_D = 1.1 \times 10^{15} \exp(-55\,900/RT)\ \mathrm{sec}^{-1}$. The rate constant (from combined data on DMM loss and CH_4 formation) extrapolated to the fully inhibited, high-pressure limit is: $k_1 = 5.0 \times 10^{15} \exp(-57\,900/RT)\ \mathrm{sec}^{-1}$. The data for the uninhibited decomposition agree with the literature; a partial mechanism is suggested which predicts the transition from chain to nonchain behaviour with increasing temperature. For the inhibited reaction the following mechanism is proposed: (1) $Hg(CH_3)_2 \rightarrow HgCH_3 + CH_3$, (2) $HgCH_3 \rightarrow Hg + CH_3$, (3) $CH_3 + Hg(CH_3)_2 \rightarrow CH_4 + CH_3HgCH_2$, (4) $CH_3 + C_5H_{10} \rightarrow CH_4 + C_5H_9$, (5) $CH_3 + Hg(CH_3)_2 \rightarrow C_2H_6 + HgCH_3$, (6) $2\ CH_3 \rightarrow C_2H_6$, (7) $CH_3HgCH_2 \rightarrow HgCH_3 + CH_2$. Using the present value of E_1 = 57.9 ± 1.4 kcal/mole in conjunction with known thermochemical data, E_2 = 0 ± 3 kcal/mole. From the inhibition data, k_3/k_4 = 0.7 ± 0.2 at 300° C, with a very small temperature coefficient. The inert gas pressure effect is evidence for the unimolecular nature of step (1).

541.127

7566. KINETICS OF THE THERMAL DECOMPOSITION OF DIMETHYLMERCURY. II. CARBON-13 ISOTOPE EFFECT.

M.E.Russell and R.B.Bernstein.

J. chem. Phys., Vol. 30, No. 3, 613-17 (March, 1959).

The C^{13} kinetic isotope effect in the pyrolysis of gaseous dimethylmercury has been studied in the presence and absence of cyclopentane inhibitor from 290-375° C for the inhibited and 290-350° C for the uninhibited reactions. The isotopic fractionation factor (S) is defined as the ratio of rate constants for the decomposition of $Hg(C^{12}H_3)_2$ versus $C^{12}H_3HgC^{13}H_3$. S shows a strong dependence upon the degree of inhibition of the methyl radical chain, which, in turn, is a function of the ratio of cyclopentane to dimethylmercury. S is also a function of the total pressure. The dependence of S upon the degree of inhibition agrees quantitatively with the predictions of the mechanism proposed in Pt I. The pressure effect on the isotope effect is attributed to the unimolecular nature of the rate determining step (Hg—C bond rupture) and is consistent with the over-all kinetics. The isotope rate factor in the fully inhibited high-pressure limit, α, is 1.034 ± 0.002 (essentially independent of temperature over the range studied), compared to a value of 1.011 ± 0.001 for the uninhibited (chain) decomposition.

541.127

7567. CURVE-MATCHING METHOD FOR QUASI-UNIMOLECULAR REACTIONS. R.E.Powell.

J. chem. Phys., Vol. 30, No. 3, 724-8 (March, 1959).

A graphical method is presented for evaluating the high-pressure limiting rate, the low-pressure limiting rate, and the parabolic exponent from data on quasi-unimolecular reactions. A logarithmic plot of k_1 against k_2, the apparent first-order and second-order rate constants, is matched against a family of theoretical curves. Computations for plotting the theoretical curves are tabulated. The technique is illustrated with data from the literature on cyclopropane and other cyclic molecules, nitrogen pentoxide, and nitrous oxide.

541.127

7568. FORMATION OF OZONE FROM ATOMIC OXYGEN AT LOW TEMPERATURES. R.A.Ruehrwein and J.S.Hashman.

J. chem. Phys., Vol. 30, No. 3, 823-6 (March, 1959).

Oxygen was passed through an electrodeless discharge and was condensed, either alone or mixed with diluent gases, at liquid temperature. On warming through a temperature range of 13-30° K the blue solid deposits became more deeply coloured. The amount of ozone formed was determined. It was concluded that ozone was formed upon condensation by the predominant reactions: $O + O = O_2$, and $O + O_2 = O_3$. The experimentally observed conversion to ozone of 58% agreed well with that calculated from a rate law with k_1/k_2 = 1.3. The activation energy of these reactions was estimated to be less than 1.5 kcal.

541.127

7569. KINETICS OF NITROGEN ATOM RECOMBINATION.

J.T.Herron, J.L.Franklin, P.Bradt and V.H.Dibeler.

J. chem. Phys., Vol. 30, No. 4, 879-85 (April, 1959).

The rate of recombination of nitrogen atoms in the nitrogen afterglow was measured in a flow system using NO as a titrant and determining the NO content continuously by mass spectrometer. Above about 3 mm of mercury the reaction is predominantly homogeneous and third order. The rate constant, 5.7 × 10^{15} cc^2 $mole^{-2}$ sec^{-1}, is independent of temperature in the interval studied (195-450° K). The rate is reduced by substituting helium or argon for N_2 as the third body, the ratios of the third-order rate constants with these third bodies being about the same as those for recombination of iodine and bromine atoms. Below about 3 mm of mercury a pseudo-first-order wall recombination becomes important. The recombination coefficient was found to be 1.6 × 10^{-5} on a glass wall that undoubtedly was partly poisoned by water. See also Abstr. 8500 (1958).

541.127

7570. VARIABLE REACTION RATE THEORY OF POLYMER SIZE DISTRIBUTION. L.Gold.

J. chem. Phys., Vol. 30, No. 5, 1284-6 (May, 1959).

The principle of equal reactivity of polymer species in a molecular distribution may be apparent rather than actual owing to relative insensitivity of the size distribution to variations in reaction rate constants. A formalism is developed for polymerization encompassing chain-length-dependent rate constants k(x) For linear and condensation polymers, a perturbation form of so tion is outlined based upon the ad hoc assumption $k(x) = k/x^n$, n being a parameter characteristic of the system.

541.

7571. RATES OF REACTION OF HYDROGEN WITH IODINE.

J.H.Sullivan.

J. chem. Phys., Vol. 30, No. 5, 1292-300 (May, 1959).

The rates of reaction of hydrogen with iodine were measure 633.21°, 666.79°, 710.33°, and 737.93° K with at least a tenfold va ation in the hydrogen and iodine concentrations at each temperat The data were treated considering the elementary reactions to b

$$\begin{aligned} I_2 &\rightleftharpoons 2I \\ H_2 + I_2 &\rightarrow 2HI \\ 2HI &\rightarrow H_2 + I_2 \\ I + H_2 &\rightarrow HI + H \\ H + HI &\rightarrow H_2 + I \\ H + I_2 &\rightarrow HI + I \\ I + HI &\rightarrow I_2 + H \end{aligned}$$

This classical reaction has long been considered to consist sole of the simple bimolecular reactions (1) and (2). However, the at mechanism, reactions (3) to (6), is shown to account for 10% of t over-all reaction at 633° and 27% at 738° K when the iodine press is one-half atmosphere. The three independent constants k_1, k_3, k_4/k_5 in $(mole/cc)^{-1}$ sec^{-1}, are given by $\log_{10}(k_1/T^{1/2}) = 12.78 -$ $- 40740/4.575\ T$, $\log_{10}(k_3/T^{1/2}) = 12.75 - 33440/4.575\ T$, and k_4/k_5 = 0.07, 0.082, 0.117, 0.125 at the experimental temperature 633°, 667°, 710°, and 738° K.

541.

7572. DEUTERIUM ISOTOPE EFFECT IN THE REACTION O HYDROGEN MOLECULES WITH CHLORINE ATOMS AND THE POTENTIAL ENERGY OF THE H_2Cl TRANSITION COMPLEX.

J.Bigeleisen, F.S.Klein, R.E.Weston, Jr and M.Wolfsberg.

J. chem. Phys., Vol. 30, No. 5, 1340-51 (May, 1959).

The relative rates of reaction of H_2 and HD with chlorine at were measured over the temperature range of 243°-350° K. In th temperature interval, the ratio of the second-order rate constan

$$R = k_{H_2}/\Sigma k_{HD},$$

is equal to (1.24 ∓ 0.03) exp (490 ± 6/RT). A search was made HD after an unequilibrated mixture of H_2 and D_2 was half convert to hydrogen chloride by photochemical reaction with Cl_2. From failure to detect 0.02% HD in the unreacted hydrogen, a lower li is set for the ratio of the rate constants of the reactions

$$H + Cl_2 \xrightarrow{k_{16}} HCl + Cl \text{ and } H + HCl \xrightarrow{k_{17}} H_2 + Cl.$$

It is shown that the pre-exponential factors in R for the HD exp ments and in the analogous experiments on HT are in quantitativ agreement with theoretical calculations for either linear or tria ular transition states, subject to the sole restriction that k(HD + + Cl → HCl + D) is approximately equal to k(HD + Cl → DCl + H). intercomparison is made between the experimental difference in activation energies between H_2, HD, HT, and D_2 for reaction with chlorine atoms and theoretical calculations for linear and triang transition states. With the most favourable potential function fo H_2Cl, the maximum deviation between $\Delta E_{exp}^{\ddagger}$ and $\Delta E_{theor}^{\ddagger}$ is 1 Inasmuch as there are more experimental data than parameters necessary to construct the potential function of H_2Cl, the agreem between theory and experiment constitutes a positive test of the transition state formulation of the effect of isotopic substitution the rates of chemical reactions.

541

7573. N.M.R. STUDY OF THE PROTOLYSIS KINETICS IN METHANOL AND ETHANOL. Z.Luz, D.Gill and S.Meiboom.

J. chem. Phys., Vol. 30, No. 6, 1540-6 (June, 1959).

Measurements by the nuclear magnetic resonance technique the hydrogen exchange kinetics in methanol and ethanol are repo The exchange reaction is both acid and base catalyzed. The obs kinetics can be interpreted as a simple proton transfer between neutral alcohol molecule and an alcoxonium, or alcoxyde ion, respectively. In methanol a third mechanism, not involving ions was also observed. In ethanol this reaction is presumably too s for detection by the N.M.R. technique. The hydrogen exchange also studied in alcohol—water mixtures. Possible exchange me anisms are discussed and values for their respective rate const are given.

541.127

7574. RATE OF REACTION OF HYDROGEN WITH IODINE AT EQUILIBRIUM. J.H.Sullivan.

J. chem. Phys., Vol. 30, No. 6, 1577-80 (June, 1959).

Rosenbaum and Hogness [J. chem. Phys., Vol. 2, 267 (1934)] measured the rate of para to ortho hydrogen conversion in equilibrium mixtures of hydrogen, iodine, and hydrogen iodide and found that the conversion rates were about twice as fast as would be predicted by the reaction

$$H_2 + I_2 \underset{(2)}{\overset{(1)}{\rightleftharpoons}} 1HI.$$

In this paper the additional conversion in their experiments is shown to be explained by the reaction sequence

$$I + H_2 \rightarrow HI + H \qquad (3)$$
$$H + HI \rightarrow H_2 + I \qquad (4)$$
$$H + I_2 \rightarrow HI + I \qquad (5)$$
$$I + HI \rightarrow I_2 + H. \qquad (6)$$

The rate constants for the rate determining steps (1) and (3) as determined from the equilibrium data are shown to be equal to those determined in systems far from equilibrium. Upper limits can be set on the rates of two para to ortho hydrogen conversion reactions which have previously been suggested to explain the results of Rosenbaum and Hogness: an upper limit of 2.5×10^{-12} is determined for the collision efficiency of reaction (a) and a lower limit of 47 kcal is determined for the activation energy of (b)

$$H_2^p + I \rightarrow H_2^O + I \qquad (a)$$
$$H_2^p + HI \rightarrow H_2^O + HI. \qquad (b)$$

The reactions of hydrogen, both with iodine atoms and with iodine molecules, are shown to be homogeneous in Pyrex vessels at 693°K.

541.127 : 536.42

VAPORIZATION OF BERYLLIUM OXIDE AND ITS REACTION WITH TUNGSTEN. See Abstr. 6837

ELECTROCHEMISTRY

541.133 : 537.311.35

7575. THE CHEMICAL EFFECTS OF PRESSURE. V. THE ELECTRICAL CONDUCTIVITY OF WATER AT HIGH SHOCK PRESSURES. H.G.David and S.D.Hamann.

Trans Faraday Soc., Vol. 55, Pt 1, 72-8 (Jan., 1959).

It is found that water becomes highly ionized when it is compressed by intense shock waves. A number of measurements at shock pressures between 33 000 and 127 000 atm have shown that the specific conductance rises steadily, reaching about 1 Ω^{-1} cm^{-1} at the highest pressure. It is concluded that most of the change is due to an increase in the ionic product of water, possibly by a factor as great as 10^{12} at 127 000 atm. The experimental method is described in some detail.

541.133 : 621.317.331

7576. A METHOD FOR THE ELECTRODELESS MEASUREMENT OF THE ELECTRICAL CONDUCTIVITY OF ELECTROLYTES. H.Hinkelmann.

Z. angew. Phys., Vol. 10, No. 11, 500-3 (Nov., 1958). In German.

The electrolyte forms the conducting link between two small transformers wound on ferrite cores. Additional windings connect the transformers via a resistance and inductance, and three stages of amplification interposed between the main windings convert the system into an oscillator. The frequency of oscillation is critically dependent on the electrolyte conductivity which is therefore measured with great accuracy. The range of conductivites covered by a given set of circuit components is, however, very small. The circuit is analysed in detail. K.W.Plessner

541.133.1

7577. THE VELOCITY FIELD IN ELECTROLYTIC SOLUTIONS. R.M.Fuoss.

J. phys. Chem., Vol. 63, No. 4, 633-6 (April, 1959).

The velocity field produced in an electrolytic solution by an external electric field has been studied further. Both the hydrodynamic term in the relaxation field and the Onsager electrophoresis term can be derived from the Navier–Stokes equation, specialized to the conductance problem. It is shown that the hydrodynamic radius which appears in the analysis must be identified with a, the centre-to-centre distance at contact between ions of opposite charge. If the ions are represented as spheres of diameter a, then the hydrodynamic radius R is twice the electrostatic radius; this result follows from the facts that no charge except that of the reference ion can penetrate a sphere of radius a around the latter and that information concerning size can only be detected conductimetrically from the consequences of interionic contacts.

541.134

7578. THE DEBYE EFFECT IN ELECTROLYTIC AND COLLOIDAL SOLUTIONS IN HIGH FREQUENCY ACOUSTIC FIELDS. A.Carrelli, G.Cozza and F.Gaeta.

Nuovo Cimento, Vol. 11, No. 1, 139-41 (Jan. 1, 1959).

The prediction by Debye (Abstr. 1626/1933) of differences in potential between contiguous layers of electrolytic solutions in the direction of ultrasonic wave propagation and an extension of this prediction to colloidal solutions by Hermans (Abstr. 1388, 4751/1938) has been checked experimentally. The ultrasound was generated by a quartz probe in the liquid at 495 kc/s, the potential pickup consisting of two metal electrodes which could be accurately spaced by a micrometer. The pick up electrodes were connected to an amplifier with a gain of 3.5×10^3, the output current being measured with a microammeter. Although a sensitivity to 10^{-6} V is claimed, neither of the above effects could be confirmed. It is suggested that the reason for this is that in electrolytic solutions the ions are surrounded by strongly bound clusters of solvent dipoles and the friction coefficient will depend on the cluster mass and not at all on the ion as is necessary to the Debye theory. Adsorption of solvent molecules on the particles in colloidal solutions would similarly account for no effect being found in these cases. T.C.Toye

541.135 : 532.7

7579. TRANSPORT PROCESSES IN LIQUID ALLOYS. I. A TRANSPORT CELL FOR LIQUID ALLOYS. P.C.Mangelsdorf, Jr.

J. chem. Phys., Vol. 30, No. 5, 1170-9 (May, 1959).

An electrolysis cell has been devised, using a thin ribbon-shaped capillary, which permits the measurement in a single experiment of the resistivity, the electrolytic mobility, and the diffusion rate in a single sample of liquid alloy. The apparatus has been used to study cadmium amalgams at 25° and 150°C, and the results are found to agree with existing data for each of the three properties.

541.135 : 530.162

GENERAL APPROACH TO THE STUDY OF ELECTRICAL CONDUCTANCE AND ITS RELATION TO MASS TRANSPORT PHENOMENA. See Abstr. 6547

541.135 : 534.23

PHENOMENOLOGICAL THEORY OF ULTRASONIC VIBRATION POTENTIALS IN LIQUIDS AND ELECTROLYTES. See Abstr. 6643

PHOTOCHEMISTRY

RADIATION CHEMISTRY

541.14

7580. LARGE REVERSE CARBON ISOTOPE EFFECT. P.E.Yankwich and R.W.Buddemeier.

J. chem. Phys., Vol. 30, No. 2, 861-2 (March, 1959).

This has been found in the photolysis (by light from a mercury arc lamp) of the uranyl ion—oxalic acid system. The mole fraction ($\times 10^6$) of C^{13} in the carbon dioxide from the combustion of oxalic acid was 10 915 ± 4; analysis of the product gases from the photolysis yielded the corresponding values: carbon dioxide, 10 786 ± 12; carbon monoxide 11 054 ± 7. This (reverse) effect is suggested as being due to the strengthening of the carbon—oxygen bonding in the photolyte complex upon activation. W.Good

541.15

7581. ON THE DECREASE IN HYDROGEN YIELD DURING CYCLOHEXANE RADIOLYSIS. W.S.Guentner, T.J.Hardwick and R.P.Nejak.

J. chem. Phys., Vol. 30, No. 2, 601 (Feb., 1959).

The cyclohexane was irradiated with 2.9 MeV electrons from a Van de Graaff accelerator. The limited hydrogen yield was found to be 5.4 ± 0.3 molecules per 100 eV. This decreases markedly as the total energy absorbed increases, and more so than would be expected from existing data. The use of the system for the determination of the energy absorbed is of questionable value. W.Good

541.15
7582. THERMAL DECOMPOSITION OF IRRADIATED SOLIDS.
E.G.Prout.
Nature (London), Vol. 183, 884-5 (March 28, 1959).

A brief review is given of the effect of irradiation of solids on their subsequent thermal decomposition. For caesium and rubidium permanganates the induction periods are shortened and the maximum velocities of reaction increased, whereas no changes are observed with neutron- or γ-irradiated silver oxide. B.T.M.Willis

DISPERSIONS . COLLOIDS . ADSORPTION

541.18 : 537.531
SMALL ANGLE X-RAY SCATTERING FROM POLYDISPERSE SOLUTIONS OF ELLIPSOIDAL PARTICLES. See Abstr. 7040-1

541.182 : 531.715 : 613.84
7583. SIZE DISTRIBUTION OF TOBACCO SMOKE PARTICLES.
E.Harris and H.F.Kay.
Nature (London), Vol. 183, 741-2 (March 14, 1959).

Electron micrographs were taken of tobacco smoke particles collected on "Formvar" films and histograms were drawn to show the size distribution under various conditions. An effect due to filtering in the cigarette and in the lungs was demonstrated but it was also shown that there is a change in the distribution of particle size with age of the smoke which masks the filtering action to some extent. L.E.Mussell

541.182 : 551.594.14
7584. DETERMINATION OF THE PERIODS OF STABILITY OF AEROSOLS FROM THE RaD AND RaF CONTENT OF ATMOSPHERIC AIR AND ATMOSPHERIC PRECIPITATIONS.
L.Lehmann and A.Sittkus.
Naturwissenschaften, Vol. 46, No. 1, 9-10 (1959). In German.

By introducing a constant of separation λ_V, the authors derive mathematical relationships for the equilibria between the RaC and RaD, or RaD and RaF, concentrations, respectively. While the periods of stability of aerosols, derived from RaC/RaD, agree well with the values obtained by Blifford et al [J. Geophys. Res., Vol. 57, 499 (1952)] and by Haxel and Schumann (Abstr. 10126/1955), those obtained from the RaF/RaD ratio are ca. 10 times greater. An attempt is made at explaining this discrepancy by assuming that the troposphere consists roughly of two layers differing widely in the period of aerosol stability. F.Lachman

541.182.6
7585. INVESTIGATION OF ACCUMULATION AND PERSISTENCE TIME OF ULTRASONIC STRIATION GRATING OF STARCH SUSPENSIONS IN LIQUIDS. B.Ramachandra Rao and C.Krishnamu
Nuovo Cimento, Vol. 11, No. 2, 212-19 (Jan. 16, 1959).

The dependence of accumulation of particles in suspension with the grain size on application of an ultrasonic field has been determined for starch suspensions in water. The formation and persistence of striations in starch suspensions in nitrobenzene, glycerine, toluene, and benzene and in agar agar sol at different stages of gelatinization have also been studied. Results illustrate the dependence on viscosity. G.I.W.Llewely

541.18
7586. ADSORPTION OF HYDROGEN ON SILICON. J.T.Law.
J. chem. Phys., Vol. 30, No. 6, 1568-76 (June, 1959).

The adsorption of both atomic and molecular hydrogen on silicon films and single crystals was studied. The kinetics of the processes as a function of coverage and gas pressure are discusse and it is shown that in the case of adsorption of atoms, two types of adsorbed species exist. Data obtained for the areas of silicon film as a function of the number of silicon atoms evaporated are in good agreement with previous work.

541.183 : 539.1
β-TYPE INTERLAMMELLAR SORPTION COMPLEXES.
See Abstr. 7472

541.183 : 539.21
ADSORPTION CHARACTERISTICS OF CLEAN SURFACES OF GERMANIUM AND SILICON. See Abstr. 7530

541.18
7587. ADSORPTION AND DESORPTION OF MOISTURE IN FIRED CERAMIC MATERIALS. F.Vaughan and A.Dinsdale.
Nature (London), Vol. 183, 600-1 (Feb. 28, 1959).

Moisture expansion in fired ceramic materials has been show to be reversible. For complete desorption of a steam-expanded material it is necessary to heat to at least 1000°C. It is difficult to establish a datum line because moisture—expansion measurements on treated materials may include an expansion of unknown extent that has occurred during cooling in the kiln. It has been found that a given weight of water adsorbed at room temperature produces a change of size different from that caused by adsorption of the same weight of water in steam treatment. The main crystalline phases in fired ceramics have been found to have a negligible moisture expansion, whereas glassy phases have a high expansion. R.Schnurma

CHEMICAL ANALYSIS

544.62 : 537.5
CHARACTERISTICS OF A COMBINATION DISCHARGE AND ITS APPLICABILITY IN SPECTROCHEMICAL ANALYSIS OF METALS. See Abstr. 7017

CRYSTALLOGRAPHY

548.0 : 534.25

588. ON AN ELLIPTIC CONE OF INTERNAL REFRACTION 'OR QUASI-TRANSVERSE WAVES IN TETRAGONAL CRYSTALS.

1.J.P.Musgrave.

.cta cryst., Vol. 10, Pt 4, 316-18 (April, 1957).

Circular cones of internal and external refraction were shown) exist for light waves in optically biaxial crystals by Hamilton .833). Recently, a circular cone of internal refraction has been hown to exist for transverse elastic waves in a cubic crystal. An nalysis is presented which shows that an elliptic cone of internal efraction may exist for quasi-transverse waves of appropriate ommon normal propagated in a tetragonal crystal. Values of the lastic constants of zircon are used to illustrate the phenomenon.

548.0 : 535.521.3

589. THE "EXTINCTION CURVE" IN THE INVESTIGATION OF 'HE OPTICAL INDICATRIX.

N.Joel and I.Garaycochea.

.cta cryst., Vol. 10, Pt 6, 399-406 (June, 1957).

A method is given for determining the orientation of the optical ıdicatrix of microscopic crystals directly from the "extinction urve", which is obtained by means of a very convenient one-axis tage goniometer. The three axes of the indicatrix appear on the rojection of the extinction curve as three points X, Y, Z, which orm a "triangle". The geometrical determination of this triangle eads in general to two solutions: the "true triangle" and a "ghost riangle". The latter has some special properties by which it may e distinguished from the "true triangle", and thus the three axes of ıe ellipsoid may be determined. Each of the three axes can then be lentified. The possibility of the method was first studied by means f a graphical survey of numerous typical cases. Accuracy tests ıd a brief mathematical treatment of the problem are also given.

548.0 : 535.323

590. REFRACTIVITY AND LATTICE CONSTANT RATIOS OF ITHIUM-6- AND LITHIUM-7-RICH FLUORIDES.

.W.H.Stevenson and P.T.Nettley.

ature (London), Vol. 183, 1000-1 (April 4, 1959).

The differences in refractivity at various wavelengths, between ı LiF crystal with 90% Li^6 and one with 95% Li^7, were measured, ıd are in agreement with calculations based on X-ray dispersion ıd thermal expansion data.

J.Hawgood

548.1

591. THE DETERMINATION OF THE CRYSTALLOGRAPHIC IRECTIONS OF PATHS IN CRYSTALS.

J.W.Davisson.

cya cryst., Vol. 10, Pt 2, 97-8 (Feb., 1957).

Linear transformation equations are derived which relate the ystallographic directions of paths uniquely to their angles of inination and azimuth in any crystal plate of known orientation.

548.2

592. ANHYDRITE OBTAINED BY THE DEHYDRATION OF YPSUM.

M.Atoji.

chem. Phys., Vol. 30, No. 1, 341-2 (Jan., 1959).

A large single crystal was dehydrated by heating to 500°C, elding a polycrystalline anhydrite block. The shape and cleavage operties of this block were the same as for the initial gypsum ystal, except that the (010) cleavage was greatly enhanced in the ıhydrite block. Microscopic examination indicated that this enınced cleavage was due to an anisotropic dehydration process, in ıich water was driven off in sheets parallel to (010).

B.T.M.Willis

548.24

593. THE PREDICTION OF TWINNING MODES IN METAL RYSTALS.

M.A.Jaswon and D.B.Dove.

cta cryst., Vol. 10, Pt 1, 14-18 (Jan., 1957).

A new crystallographic analysis of deformation twinning in mulple lattices is developed. This enables the operative twinning odes to be predicted for all metal crystals, including α-uranium. easons are given for the non-appearance of certain modes expected eoretically.

548.24

94. RELATION OF SYMMETRY TO STRUCTURE IN WINNING.

K.Dornberger-Schiff.

cta cryst., Vol. 12, Pt 3, 246 (March, 1959).

The twin boundary layer in an OD structure need not possess any symmetry element additional to those of the crystal. Twin boundaries with additional symmetry elements have already been described [W.T.Holser, Zietschrift für Kristallographie, Vol. 110, 249 (1958)].

J.Franks

548.5 : 611.365 : 621.365.9 : 621.315.59

7595. THE GROWING OF 5 kg SINGLE CRYSTALS OF GERMANIUM.

J.G.Wilkes.

Proc. Instn Elect. Engrs, Paper 2934E [International Convention on Transistors and Associated Semiconductor Devices], publ. May, 1959, 5 pp. To be republished in Vol. 106B (1959).

Consideration of the factors involved in the efficient production of semiconductor devices reveals the desirability of growing large single crystals of germanium. The technical specification for the material demands that this shall not be achieved at the expense of quality, i.e. the germanium must be of the correct resistivity, lifetime and dislocation density. The realization of the potential advantages has involved the solution of a range of problems. In pulling large crystals the growth must be precisely controlled to give the level interface conditions and thermal gradients associated with good crystal perfection and uniform transverse properties. A high-vacuum radiation-heated furnace is used in which the heater-baffle assembly is fabricated from high-purity graphite, silica and molybdenum. In this assembly the mechanical construction, the heater and the disposition of the baffle system need careful design to obtain the necessary high-temperature rigidity and the correct heat field over the area involved. (The crucible internal diameter is 150 mm). Both stationary and rotating crucible systems have been successfully used, the rotating type having several advantages. Melt preparation demands a high standard of chemical cleanliness, and this is more difficult to attain with large quantities than with small quantities of material. A technique has been developed based on a potassium-hydroxide/hydrogen-peroxide etch which is both safe and completely satisfactory chemically.

548.5 : 537.311.33

7596. VAPORIZATION—CRYSTALLIZATION METHOD FOR GROWING CdS SINGLE CRYSTALS.

D.R.Boyd and Y.T.Sihvonen.

J. appl. Phys., Vol. 30, No. 2, 176-9 (Feb., 1959).

A self-refining method for growing three different forms of CdS single crystals is described together with fabrication details of the 1300 W three-temperature zone furnace employed. The growth chamber measuring $1\frac{3}{4}$ in. in diameter × 21 in. long is charged with CdS powder and either H_2S or argon at a pressure of 1 atm or less, and subjected from 4 to 7 days to different temperatures ($1250 \pm 2^\circ$C maximum) and gradients depending on the type of crystal desired. Single crystals vary from thin plates, rods, and whiskers weighing fractions of a gram to 10-g polygonal chunks. The method is believed to be suitable for growing single crystals of many other elemental and compound semiconductors.

548.5

7597. NITROGEN IN SILICON.

W.Kaiser and C.D.Thurmond.

J. appl. Phys., Vol. 30, No. 3, 427-31 (March, 1959).

Liquid silicon was exposed to gaseous ambients containing varying concentrations of N_2 or NH_3. Under certain conditions, Si_3N_4 needles may be grown on the surface and into the body of the melt. The molten zone of silicon was supported between two rods of solid silicon. It was found that the concentration of nitrogen in molten silicon which is saturated with respect to silicon nitride at a temperature near the melting point of silicon is around 10^{19} atoms per cm^3. During the freezing of the melt, Si_3N_4 precipitates from the supersaturated liquid phase. The concentration of electrically active impurity states in silicon grown from melts containing around 10^{19} atoms per cm^3 of nitrogen is less than 10^{12} atoms per cm^3.

548.5

7598. GROWTH OF SILICON CRYSTALS FREE FROM DISLOCATIONS.

W.C.Dash.

J. appl. Phys., Vol. 30, No. 4(1), 459-74 (April, 1959).

The dislocations which occur in silicon crystals grown by the Czochralski method with and without a crucible are studied by etching and copper decoration techniques. A representative crystal with about 500 dislocations per cm^2 is examined in detail to provide general information about their distribution. Sources of dislocations which are important at particular stages of growth are isolated and means found to minimize or eliminate them. The sources include generation by thermal shock from surface damage or residual dislocations in the seed; poor epitaxy at the seed; plastic generation in the bulk of the crystal; effects of segregation of impurities. Plastic generation is the only source found in the bulk of a crystal. "Spontaneous" formation of dislocations from excess vacancies is not found. Impurity segregation causes some generation at the tip end of crystals. For certain crystallographic directions it is possible to eliminate residual dislocations and thenceforth grow a dislocation-free crystal. This is interpreted in terms of climb. In a supersaturation of vacancies, an edge dislocation can be forced completely out of a crystal; a screw will remain straight or may be distorted into a coaxial helix. By growth along ⟨100⟩ or ⟨111⟩ axes under conditions which favour a vacancy supersaturation, screw as well as edge and mixed dislocations can propagate to the surface and be eliminated. The observations are consistent with this interpretation. When the dislocations are eliminated, the growing crystal can withstand large temperature fluctuations without further generation of dislocations. A procedure is outlined for the growth of dislocation-free silicon crystals. Germanium crystals free of dislocations have been grown by a direct application of the method. It is believed that the conclusions reached during the course of this investigation may be applied to the development of methods for growing dislocation-free crystals of other substances.

548.5

7599. ENTROPY EFFECT IN ICE CRYSTAL NUCLEATION.
N.H.Fletcher.
J. chem. Phys., Vol. 30, No. 6, 1476-82 (June, 1959).

The effect of bond orientation in ice, which leads to its residual entropy, is also found to be important in its heterogeneous nucleation. Any substrate which orients ice dipoles at its surface parallel to one another is a poor nucleating agent, because it reduces the entropy and hence raises the free energy of any small embryos growing upon it. Critical temperatures are calculated for surfaces of this type, and it is shown that for crystals like AgI or PbI_2 the basal faces are poor ice crystal nuclei, and activity is mostly confined to the prism faces. This result leads to improved agreement between observed and theoretical nucleation thresholds and gives an explanation of some of the phenomena observed in nucleation by monocrystalline substrates.

548.5 : 539.2

DISLOCATION ETCH PITS IN BISMUTH. See Abstr. 7507

548.51 : 551.578.4

7600. ON ICE-CRYSTAL PRODUCTION BY AEROSOL PARTICLES. N.H.Fletcher.
J. Meteorol., Vol. 16, No. 2, 173-80 (April, 1959).

A general theory of the action of small aerosol particles as ice-crystal nuclei is developed and its predictions compared with experiment. It is found possible to decide under what conditions a given particle will act as a sublimation or as a freezing nucleus, and it is concluded that silver iodide generally behaves as a sublimation nucleus. The size effect is used to explain the activity distribution of silver iodide smoke, and this in turn explains the time lag observed in the nucleation of ice crystals by this smoke.

548.54

7601. THE EQUILIBRIUM FORMS OF CRYSTALS. P.Hartman.
Acta cryst., Vol. 11, Pt 7, 459-64 (July, 1958).

The face development of the equilibrium form of a crystal is discussed. The most important faces are F faces. For non-ionic crystals it is found that the equilibrium form may also exhibit S and K faces. The surface energy of S and K faces is expressed in terms of the surface energies of neighbouring F faces plus a correction term. The size of each of these S and K faces is determined by the magnitude of this correction term. For the S faces in a certain zone this correction term is expressed in terms of the interaction energies of periodic bond chains parallel to the zone axis. The S faces appear on the equilibrium form as strips. The breadth of each S face is proportional to a certain negative power of its mesh area. As a consequence the morphological importance of an S face is a rapidly decreasing function of its mesh area. This relation includes the law of Donnay and Harker for separate zones. The K faces are much smaller than the S faces and are unimportant. For ionic crystals the law of Donnay and Harker may fail even for a separate zone. In this connection the angular dependence of the interaction energy of two parallel ionic chains is discussed.

548.574 : 539.2

7602. ETCH PATTERNS IN ZINC. V.V.Damiano and M.Herman.
J. Franklin Inst., Vol. 267, No. 4, 303-15 (April, 1959).

Loops and spiral etch patterns were observed on surfaces
parallel or nearly parallel to the basal plane of zinc. Their motio
and growth were recorded and appeared similar to the mechanism
proposed by Frank and Read (Abstr. 673/1951) for the generation
dislocations. These observations have been tentatively interprete
as the dissolution of a step in the surface with the ends of the step
pinned.

X-RAY CRYSTALLOGRAPHY

548.73/.

X-RAY AND ELECTRON INVESTIGATION OF MATERIALS. See also the Section entitled "STRUCTURE OF SOLIDS".

548.73 : 539.2 : 537.5

ANALYSIS OF SMALL-ANGLE X-RAY SCATTERING FROM DEFORMED AND IRRADIATED METALS. See Abstr. 7042-8, 75

548.7

7603. X-RAY DIFFRACTION FROM BODY-CENTRED CUBIC CRYSTALS CONTAINING STACKING FAULTS.
P.B.Hirsch and H.M.Otte.
Acta cryst., Vol. 10, Pt 7, 447-53 (July, 1957).

Calculations are presented of the intensities diffracted from
polycrystalline specimens of body-centred cubic crystals containin
stacking faults on (211) planes. Possible applications of the theory
to the anomalous line broadening from martensite and from cold-worked iron are discussed.

548.7

7604. CALCULATION OF THE MACRO ABSORPTION FACTOR FOR A CYLINDRICAL SPECIMEN IRRADIATED WITH A FINE BEAM. A.R.B.Skertchly.
Acta cryst., Vol. 10, Pt 8, 535-6 (Aug., 1957).

The principle of the calculation is given and some specimen results for meridional and equatorial reflections plotted.

A.R.Stok

548.7

7605. THE EFFECT OF CRYSTAL SHAPE AND SETTING ON SECONDARY EXTINCTION. W.C.Hamilton.
Acta cryst., Vol. 10, Pt 10, 629-34 (Oct., 1957).

The power equations for diffraction from a single crystal of
uniform, but arbitrary, cross-section may be solved by numerica
procedures to yield secondary extinction coefficients. Calculatior
are carried out and curves are presented for both absorbing and
non-absorbing crystals of circular and rectangular cross-section
several crystal settings and Bragg angles. It is shown that the ex
tinction coefficient for crystals at rectangular cross-section can
quite sensitive to the direction of the incident beam relative to th
crystal faces; hence, if extinction is severe, the use of a cylindri
crystal is indicated. In the cylindrical crystal, the extinction co-efficient becomes noticeably dependent on the Bragg angle as the
tinction becomes more severe. A single-parameter empirical ex
tinction correction of the exponential or linear type commonly us
cannot then be valid for groups of reflections which vary widely i
Bragg angle. Only if $I_0/I_C > 0.70$ is an extinction coefficient of t
type exp $(-kI_c)$ appropriate. An estimate of the mosaic-spread p
meter may thus be obtained from the less severely extinguished r
flections and applied to the more intense reflections. The mosai
spread parameter may also be conveniently estimated from the li
ing intensity if this is experimentally observed.

548.

7606. CALCULATIONS OF COHERENT SCATTERING FACTO
FOR HELIUM-LIKE IONS FROM A RADIALLY CORRELATED W
FUNCTION. R.P.Hurst, J.Miller and F.A.Matsen.
Acta cryst., Vol. 11, Pt 5, 320-2 (May, 1958).

Coherent scattering factors are calculated for helium and
helium-like ions from the Hylleraas—Eckart radially correlated
wave-function. It is suggested that the method may be extended
other atoms with less labour than is required to make Hartree—
type calculations. A sizeable disparity between corresponding c
related and uncorrelated results is noted for H^-; this gradually
comes smaller with increasing atomic number. At the larger va
of sin θ/λ, the correlated results for H^- agree quite well with co
responding factors for the hydrogen atom.

548.732

607. A POLYNOMIAL APPROXIMATION TO ATOMIC CATTERING FACTOR CURVES. H.C.Freeman and J.E.W.L.Smith. cta cryst., Vol. 11, Pt 11, 819-22 (Nov., 1958).

Coefficients for sixth-degree polynomials for elements from to Rb are tabulated, the range of $\sin\theta/\lambda$ being 0 to 0.7. They re intended for use with computers whose storage is not large.

A.R.Stokes

548.732

608. CONTRIBUTIONS OF ONE- AND TWO-PHONON SCATTERNG TO TEMPERATURE DIFFUSE SCATTERING. A.Paskin. cta cryst., Vol. 11, Pt 3, 165-8 (March, 1958).

Borie (Abstr. 2838/1957) has given a procedure for obtaining he atomic scattering factor and the Debye–Waller factor independntly from a set of X-ray measurements taken at one temperature. analysing the temperature diffuse scattering, use was made of Varren's formula derived for the case that the Debye–Waller factor much less than unity and based on single-phonon scattering. orie has extended Warren's formula into a region where the ebye–Waller factor is of the order of unity and where two-phonon rocesses are as important as one-phonon contributions. It is here hown why the Warren formula is a better approximation than the sual single-phonon temperature diffuse scattering term. A ormula for two-phonon temperature diffuse scattering in powders derived and compared with experiment. The importance of twohonon scattering effects is also clearly demonstrated using Borie's mperature diffuse scattering data taken on copper powders.

548.732

609. DIFFRACTION BY HELICAL STRUCTURES. .Klug, F.H.C.Crick and H.W.Wyckoff. cta cryst., Vol. 11, Pt 3, 199-213 (March, 1958).

The symmetry of helical structures and their diffraction tterns is discussed, and a list is given of the line groups for entiomorphic helical structures. The main body of the paper conrns two special kinds of projection of a helical structure — the dial projection and the helical projection. It is shown that these ojections provide a very convenient way of thinking about a helil structure and analysing its diffraction pattern. The theory of ese projections is given in detail, and their uses are discussed.

548.732

610. GROUP VELOCITY AND PHASE VELOCITY IN X-RAY RYSTAL OPTICS. P.P.Ewald. cta cryst., Vol. 11, Pt 12, 888-91 (Dec., 1958).

In a Laue type diffraction experiment in which a secondary y is split from the primary one, the propagation of energy takes ace along the net planes on which reflection occurs, rather than ong the normals of the incident or reflected waves. It is shown at this result follows directly from the existence of a surface of spersion if bundles of waves of small angular opening dΩ are bstituted for the strictly plane component waves of the X-optical eld. The direction of the group velocity is defined for each bundle d is shown to be directed along the normal to the surface of spersion (or index surface in light optics) at the point of this rface which represents one of the component plane-wave fields. he same result has been achieved by Laue in a discussion of orrmann's experiments, and, recently, by Kato for electron and -ray diffraction. The present treatment, based on the concept of oup-velocity, is more general and requires no detailed calculation the field. A further result of Kato, regarding the propagation of field of finite width, as cut out by a slit, is also given an interpretan by inspection.

548.732

11. EXPERIMENTAL STUDY OF EFFECT OF CRYSTALLITE ZE STATISTICS ON X-RAY DIFFRACTOMETER INTENSITIES. M.De Wolff, J.M.Taylor and W.Parrish. appl. Phys., Vol. 30, No. 1, 63-9 (Jan., 1959).

The relative r.m.s. deviation σ of the intensity of a rapidly tating polycrystallite specimen is $\sigma = [6.5R \sin\theta]/[h(mN_{eff})^{1/2}]$, ere R = goniometer radius, θ = Bragg angle, $h = (h_f + h_s)/2$, = length of focal spot, h_s = length of receiving slit, m = multiplicity tor, and N_{eff} the effective number of irradiated crystallites. perimental data on silicon powder specimens are presented to ow the dependence of σ on crystallite sizes, choice of X-ray wavegths and various other experimental parameters. Comparisons data for rapidly rotating and stationary specimens having crystale sizes in the 30-50 μ range show that rotation improves σ by a tor of 7 or 8 for peak intensities and 4 or 5 for integrated intenses, using a standard diffractometer.

548.732 : 537.531

7612. INTERNAL DOUBLE REFLECTION IN A PERFECT CRYSTAL. A.Guinier and E.Guyon. J. appl. Phys., Vol. 30, No. 5, 622-8 (May, 1959).

The theory of double Bragg reflections in single crystals is derived on both a kinematical and dynamical basis. Experiments are reported using single crystals of LiF, diamond, aluminium—copper, pentaerithritol and stilbene, and comparisons made with the theory.

548.732.2

7613. DIRECT MEASUREMENT OF THE ANGULAR DEPENDENCE OF THE IMAGINARY PART OF THE ATOMIC SCATTERING FACTOR OF GERMANIUM. L.P.Hunter. I.B.M. J. Res. Developm., Vol. 3, No. 2, 106-13 (April, 1959).

In the dynamical theory of the anomalous transmission of X-rays through perfect thick crystals, the ratio of transmitted intensity to incident intensity depends exponentially upon

$$[1 - Kf''_{Ge}(\theta_{hkl})/f''_{Ge}(0^0)].$$

Here K is the polarization factor and the $f''_{Ge}(\theta_{hkl})$ and $f''_{Ge}(0^0)$ are the imaginary parts of the atomic scattering factors of germanium at the angle θ_{hkl} and 0^0, respectively. This paper describes the measurement of the ratio $f''_{Ge}(\theta_{hkl})/f''_{Ge}(0^0)$ for several different sets of planes in nearly perfect germanium crystals.

548.733 : 537.531

7614. THE STUDY OF MULTIPLE REFLECTIONS WITH THE AID OF A MICROFOCUS X-RAY SOURCE. A.R.Lang. Acta cryst., Vol. 10, Pt 4, 252-4 (April, 1957).

A microfocus X-ray tube having a projected focus size ~ 30 × 3 microns used with a simple photographic recording arrangement allows clear observation of Aufhellungen in single-crystal reflections and extinction lines in the directly transmitted beam. Multiple reflections, such as an apparent "200" in diamond generated by successive reflection from two octahedral planes, can be readily identified by their special shape. It is pointed out that uncertainty of coherent-domain boundary conditions presents a serious obstacle to the derivation of information on relative phases through the study of simultaneous X-ray reflections.

548.733

7615. A SIMPLE ADAPTER FOR ROTATION CAMERAS TO IMPROVE THE ACCURACY OF MEASUREMENT OF IDENTITY PERIODS. A.McL.Mathieson. Acta cryst., Vol. 10, Pt 5, 351-4 (May, 1957).

The adaptor described makes it possible to measure identity periods from rotating-crystal photographs with an accuracy of the order of 0.1%.

548.733

7616. COUNTER DIFFRACTOMETER — THE EFFECT OF DISPERSION, LORENTZ, AND POLARIZATION FACTORS ON THE POSITIONS OF X-RAY POWDER DIFFRACTION LINES. E.R Pike. Acta cryst., Vol. 12, Pt 2, 87-92 (Feb., 1959).

The variation of $\sin\theta$ over a diffraction line in the back-reflection region is such that the centroids of spectral and observed profiles do not correspond exactly in the Bragg equation. The discrepancy has been called dispersion error. The modification of the line-profile due to the Lorentz factor causes a similar error. Previous derivations of the Lorentz factor have distinguished between the so-called "polychromatic" factor for single crystals and the "monochromatic" factor for powder work. Neither are applicable in this case since a "polychromatic" factor for powder work is required due to the finite spread of wavelengths in the characteristic lines. The new Lorentz factor is calculated, giving $P(\psi)\delta\psi \propto F(\lambda)\delta\lambda \tan\psi/2$, where ψ is the diffractometer angle ($= 2\theta$), $P(\psi)$ the observed profile, and $F(\lambda)$ the spectral profile. The polarization factor causes a somewhat smaller shift of the centre of gravity of the observed profile. A theoretical treatment of these aberrations is given. To the first order, the Lorentz factor displaces the centroid by $(2V \tan^3\bar{\theta})/\bar{\lambda}^2$ and the dispersion factor by an additional $(V \tan^3\bar{\theta})/\bar{\lambda}^2$, both towards high 2θ, where V is the variance of the spectral profile over the range used, $\bar{\theta}$ is the mean diffraction angle and $\bar{\lambda}$ the mean wavelength. The total correction has been calculated and plotted on the assumption of Cauchy spectral profiles. It is additive to, and independent of, the normal corrections for geometrical aberrations and becomes larger than these at very high angles. The total effect on the line profile can be corrected by replotting, if each reading is weighted by $(\cos\theta)^{3/2}$, but limitations of this and other replotting techniques, due to their dependence on the other aberrations present, are pointed out.

548.734.3

7617. HARMONIC REFLEXIONS WITH A CAMERA OF THE GUINIER TYPE. J.Goodyear and W.J.Duffin.
Acta cryst., Vol. 10, Pt 9, 597-8 (Sept., 1957).

It is shown that with a powder transmission camera, used with a focusing monochromator, the lines due to the λ/2 component in the incident beam may be practically eliminated by a suitable choice of thickness of the specimen. A.R.Stokes

548.734.4

7618. THE INDEXING OF REFLEXIONS IN INVESTIGATIONS INVOLVING THE USE OF THE ANOMALOUS SCATTERING EFFECT. A.F.Peerdeman and J.M.Bijvoet.
Acta cryst., Vol. 9, Pt 12, 1012-15 (Dec., 1956).

The assignment of the right sign to the index triplet of a reflection in the calculation of structure factors and in the indexing of the diagram in the Weissenberg technique is discussed. The possible use of anomalous scattering for the determination of the phase angle in the single-heavy-atom technique is pointed out.

548.734.8

7619. HIGH-SPEED COMPUTATION OF THE ABSORPTION CORRECTION FOR SINGLE CRYSTAL DIFFRACTION MEASUREMENTS. W.R.Busing and H.A.Levy.
Acta cryst., Vol. 10, Pt 3, 180-2 (March, 1957).

A programme for computation is described. The method requires that the sample boundaries be approximated by plane surfaces and that there be no re-entrant angles between these planes.

548.735

7620. SOME RELATIONS BETWEEN CRYSTAL STRUCTURES. IV. SEQUENCES OF LAYERS OF CLOSEST-PACKED SPHERES. K.Schubert.
Z. Naturforsch., Vol. 13a, No. 6, 443-51 (June, 1958). In German.

For previous work, see Abstr. 9981 (1957). An approximate formula for the potential energy of electrons in a crystal structure in terms of the position-correlation function leads to a consideration of structures of the types of copper, zinc, brass, mercury and ruthenium. A.R.Stokes

548.735.2

7621. A UNIFIED ALGEBRAIC APPROACH TO THE PHASE PROBLEM. I. SPACE GROUP P$\bar{1}$. H.Hauptman and J.Karle.
Acta cryst., Vol. 19, Pt 4, 267-70 (April, 1957).

Under certain limitations, the approach yields explicit formulae for determining the sign of any structure factor. Some of these formulae correspond to those previously derived and throw additional light on them, while others provide a useful addendum to these relations. The unified algebraic approach provides, in general, a basis for deriving phase-determining relations in all the space groups.

548.735.2

7622. A UNIFIED ALGEBRAIC APPROACH TO THE PHASE PROBLEM. II. SPACE GROUP P1. J.Karle and H.Hauptman.
Acta cryst., Vol. 10, Pt 8, 515-24 (Aug., 1957).

For Pt I, see preceding abstract. A procedure is given for phase determination in the space group P1. Least-squares adjustments for refining the phases so determined are also described. Some simple examples are given which illustrate the application of the procedure.

548.735.2

7623. PHASE DETERMINATION FROM NEW JOINT PROBABILITY DISTRIBUTIONS: SPACE GROUP P$\bar{1}$. H.Hauptman and J.Karle.
Acta cryst., Vol. 11, Pt 3, 149-57 (March, 1958).

New joint probability distributions of several normalized structure factors are obtained by fixing the crystal structure and allowing the indices to range uniformly but not independently over the vectors in reciprocal space. From these the expected values of the product of powers of several structure factors are found. A subsequent integrating process, together with an important identity, then yield greatly improved formulae for phase determination by means of which the phases of the structure factors are obtainable from the magnitudes of the structure factors alone. Owing to the greater power of these formulae the data are used more efficiently, and complex structures may be more readily analysed than heretofore.

548.735.2

7624. PHASE DETERMINATION FROM NEW JOINT PROBABILITY DISTRIBUTIONS: SPACE GROUP P1. J.Karle and H.Hauptman.
Acta Cryst., Vol. 11, Pt 4, 264-9 (April 10, 1958).

The method of derivation is the same as that described previously (see preceding abstract).

548 735.

7625. A GENERAL THEORY OF INEQUALITIES. J.Bouman.
Acta cryst., Vol. 9, Pt 10, 777-80 (Oct., 1956).

The method used by Karle and Hauptman (Abstr. 6170/1950) for deriving inequalities is applied to structures possessing a centr of symmetry. It is shown that all inequalities which have been derived, or may be derived, may be found by purely algebraic mear from four sets of inequalities, the fundamental inequalities. The fundamental sets, derived previously by de Wolff and Bouman (Abstr. 7027/1954), appear among them.

548.735.

7626. A NEW TYPE OF INEQUALITY RELATIONSHIP BETWEE UNITARY STRUCTURE FACTORS. E.W.Hughes.
Acta cryst., Vol. 10, Pt 5, 376-7 (May, 1957).

Describes a method for the derivation of inequality relationships other than those discussed by Bouman (see preceding abstrac J.Thewl

548.735

7627. MATRIX-THEORETICAL DERIVATION OF INEQUALITIE I.Taguchi and S.Naya.
Acta cryst., Vol. 11, Pt 8, 543-5 (Aug., 1958).

Using the matrix theory, a general type of inequalities for P1 and P$\bar{1}$ is derived. The results obtained for P1 are the same as th derived by Karle and Hauptman (Abstr. 6170/1950).

548.735

7628. AN IMPROVEMENT OF THE "HEAVY-ATOM" METHOD OF SOLVING CRYSTAL STRUCTURES. M.M.Woolfson.
Acta cryst., Vol. 9, Pt 10, 804-10 (Oct., 1956).

For the normal heavy-atom method of solving crystal structur the Fourier series, whose coefficients are given in moduli by the c served intensities and in phase by the heavy-atom contribution, is summed. It is shown that a Fourier series with coefficients quite different from these shows the unknown part of the structure more clearly. A criterion for determining the degree of resolution of a structure is given and the advantage of the new series is demonstrated both theoretically and by means of practical examples.

548.735

7629. A DIRECT APPLICATION OF ELECTRONICALLY-PRESENTED OPTICAL TRANSFORMS. A.Menarry and H.Lipson
Acta cryst., Vol. 10, Pt 1, 27-9 (Jan., 1957).

The orientation of a plane molecule in a crystal structure can found relatively quickly by the optical-transform method. An appreciable amount of time, however, is taken up by the production c the transform on a suitable scale and by the subsequent steps nece sary to deduce the orientation. Both these stages can be eliminat by the direct presentation on a television monitor; it then becomes possible to orient the mask in the optical diffractometer so that th diffraction pattern matches the weighted reciprocal-lattice sectio The two parameters giving the orientation of the molecule can the be read directly on circular scales. Two examples of the procedu are described, one for a known structure and one for an unknown structure. Each result was obtained in about 45 min.

548.73

7630. AN EFFICIENT PROCESS FOR SOLVING CRYSTAL STRUCTURES BY SIGN RELATIONSHIPS. M.M.Woolfson.
Acta cryst., Vol. 10, Pt 2, 116-20 (Feb., 1957).

It is shown that, by expressing sign relationships in a suitabl tabular form, it is possible to deduce signs for other structure fa tors if the signs are known for the structure invariants (the struc factors of even indices whose signs do not vary with the choice of origin of the unit cell). The economy introduced by considering o the structure invariants as unknowns, and not all the structure fa makes possible the determination of reasonably complex structur by hand calculation. The application of the method to the structur of azo-benzene 2-sulphenyl chloride is described.

548.73

7631. THE FRACTION OF STRUCTURE FACTORS DETERMIN IN SIGN BY A SELECTED ATOM OR GROUP OF ATOMS IN A MOLECULE. G.A.Sim.
Acta cryst., Vol. 10, Pt 3, 177-9 (March, 1957).

The number of structure factors whose signs are determined the presence in a molecule of a selected atom, or group of atoms is calculated in terms of the ratio of the root-mean-square contr tion to the structure factors of the atom or atoms to that of the r mainder of the molecule, and is expressed as a fraction of the tot number of structure factors.

548.735.4

7632. THE INTEGRAL TRANSFORMATIONS OF ATOMIC SCATTERING FACTORS AND THEIR APPLICATIONS. M.Atoji.
Acta cryst., Vol. 10, Pt 4, 291-303 (April, 1957).

The Fourier, Hankel and Gauss transformations of atomic scattering factors, expressed in analytical forms obtained from the electronic wave functions and from the Thomas—Fermi method, are discussed. These transformations, in three dimensions and in projection, are applied to observe the effect of thermal vibrations on the electron distribution in all atoms, in connection with the accuracy of atomic coordinates in the electron-density maps and with the series-termination effect in X-ray Fourier methods. Some of the important results are as follows. All atomic scattering factors can be expressed in the closed form

$$\sum_n H/(s^2 + E)^n,$$

where E and H are independent of $s = 2 \sin \theta/\lambda$. The iso-electronic atoms such as F^- and $O^=$ may well be distinguishable from the peak values of the electron-density distribution. The Thomas—Fermi method is found to be a satisfactory approximation even for the lighter atoms, provided that their thermal vibrations are large. The following relation between the peak height, $\rho_n(0)$, and the peak curvature $\rho''_n(0)$, may be useful for the refinement of the temperature factor

$$16\pi^2 \partial\rho_n(0)/\partial B = n\rho''_n(0),$$

where n is the dimension of the projection. The possibility for the determination of the characteristic temperature, using the electron-density data from X-ray methods, is suggested. The agreement between the observed and calculated values of the electron-density function is quite reasonable.

548.735.4

7633. ANALYTICAL REPRESENTATION OF ATOMIC SCATTERING FACTORS. V.Vand, P.F.Eiland and R.Pepinsky.
Acta cryst., Vol. 10, Pt 4, 303-6 (April, 1957).

Atomic scattering factors can be expressed analytically by an expansion of Gaussian functions. A two-term expansion is sufficiently accurate to cover the Cu Kα range of scattering angles occurring in crystallographic calculations. For the Mo Kα range, one extra constant is to be added. The constants of the two-term expansion are evaluated for all the elements. The function fits the tabulated atomic scattering factors to better than 1% of f(0) in most cases.

548.735.4

7634. FOURIER TRANSFORMS IN CYLINDRICAL CO-ORDINATES. A.M.Cormack.
Acta cryst., Vol. 10, Pt 5, 354-8 (May, 1957).

A brief account is given of some of the mathematics pertinent to the calculation of Fourier transforms in cylindrical co-ordinates, and a systematic derivation is given of the Fourier transforms of a number of curves and surfaces which are most naturally expressed in cylindrical co-ordinates.

548.735.4

7635. THE FOURIER TRANSFORM METHOD FOR NORMALIZING INTENSITIES. N.Norman.
Acta cryst., Vol. 10, Pt 5, 370-3 (May, 1957).

A method for bringing experimental intensities to an absolute scale, based on the value of the electron distribution function r = 0, is described. Formulae for the normalization constant are given for crystals and samples of spherical and cylindrical symmetry. The formulae represent approximate values. As an example, the percentage error in the normalization constant for cellulose is calculated as a function of the radius of the limiting sphere in reciprocal space, and the calculations are compared with experimental results.

548.735.4

7636. SOME NEW RELATIONS FOLLOWING FROM THE HERGLOTZ THEOREM. M.Atoji.
Acta cryst., Vol. 10, Pt 7, 464 (July, 1957).

An account is given of the way in which the use of positive-definite determinants of Fourier coefficients may lead to useful inequality relations if the electron-density distribution is known in parts of the unit cell. J.Thewlis

548.735.4

7637. PHASE DETERMINATION BY THE TWO-WAVELENGTH METHOD OF OKAYA AND PEPINSKY. C.M.Mitchell.
Acta cryst., Vol. 10, Pt 7, 475-6 (July, 1957).

See Abstr. 889 (1957). It is shown that the method may be applied to centrosymmetric crystal structures, and that intensities obtained from powder photographs may be used in this case to determine phases of reflections. A.R.Stokes

548.735.4

7638. A METHOD FOR THE SYSTEMATIC APPLICATION OF SIGN RELATIONS. D.F.Grant, R.G.Howells and D.Rogers.
Acta cryst., Vol. 10, Pt 8, 489-97 (Aug., 1957).

A method is described for the systematic application of the sign relation, $S(h')S(h + h') \cong S(h)$, to projections with symmetry pgg, pmg, and p4g. The procedure allows large amounts of data to be handled compactly and does not require a computer. It involves the recognition and correlation of sign "coincidences", which are defined by using a variant, $S(A)S(B)S(C) \cong +1$, of the sign relation. As a consequence of the operation of symmetry elements, the product S(A)S(B) can enter into such a relation with several different third terms, $S(C_1)$, $S(C_2)$, etc., the signs of which are said to "coincide". From these coincidences it is possible to deduce tentatively the signs of a considerable number of terms. An iterative process is used to adjust and extend the set of tentative signs so as to ensure optical agreement with the original data. The solving of two structures, harmine ($C_{13}H_{12}N_2O$) and hydroxydihydroeremophilone ($C_{15}H_{24}O_2$), by this method is described, and details are given of the results produced by EDSAC when the harmine data were submitted to the Cochran—Douglas procedure. The ability of the new method to reach a single optimum solution (in contrast to EDSAC) is discussed.

548.735.4

7639. THE CHOICE OF THE STANDARD UNIT CELL IN A TRICLINIC LATTICE. V.Balashov and H.D.Ursell.
Acta cryst., Vol. 10, Pt 9, 582-8 (Sept., 1957).

An algorism for the reduction of the experimental data directly to the three shortest non-coplanar translations (Dirichlet triplet) is given. A method is also given for deriving the Dirichlet triplet from the Delaunay reduced cell, and analysis of the latter concept shows that the Delaunay cell can have interaxial angles arbitrarily near to 180°. For the Dirichlet triplet, in contrast, the interaxial angles can never deviate by more than 30° from right angles.

548.735.4

7640. ON THE DETERMINATION OF UNIT-CELL DIMENSIONS FROM POWDER DIFFRACTION PATTERNS. P.M.de Wolff.
Acta cryst., Vol. 10, Pt 9, 590-5 (Sept., 1957).

The general approach proposed by Ito (Abstr. 2783/1950) has been successfully used for the determination of the unit cells of many compounds. The analysis of three patterns is reconstructed to illustrate several conclusions as follows. Among the simplest algebraic relations between Q values, the one Ito mentions is the most powerful for finding clues leading to a zone. Some other relations are also useful, and a general relation yields information about the mutual orientation of three zones. Determination of the Bravais type becomes automatic merely by arranging the Q's in a schematized reciprocal lattice. Any symmetry is immediately apparent because it causes the Q's to form sets of equal values for equivalent points. The analysis is simplified if this geometric point of view is taken consistently; indices need not be used explicitly until the lattice symmetry has been found. The data, obtained by using standard equipment (114 mm diameter focusing camera), were of sufficient quality to allow the determination of the unit cells even of steroids in a couple of hours, provided the line width did not appreciably exceed the instrumental width (0.05° θ at half height).

548.735.4

7641. THE CRITICAL EXAMINATION OF A WEAK SIGN RELATIONSHIP BETWEEN STRUCTURE FACTORS. M.M.Woolfson.
Acta cryst., Vol. 10, Pt 10, 635-8 (Oct., 1957).

The probability of the sign of the product $U_{h-h'}U_{h+h'}$ is derived as a function of $U_hU_{h'}$. It is found that $U_{h-h'}U_{h+h'}$ cannot be shown to be negative with a probability much exceeding $\frac{1}{2}$, a result at variance with a prediction made by Gillis (Abstr. 2845/1957).

548.735.4

7642. A PHASE-DETERMINING PROCEDURE RELATED TO THE VECTOR-COINCIDENCE METHOD. P.A.Vaughan.
Acta cryst., Vol. 11, Pt 2, 111-15 (Feb., 1958).

It is shown that one form of the vector-coincidence method is approximately equivalent to a probable calculation of certain origin-invariant products of structure factors. Equations are developed in detail for space groups $P\bar{1}$ and P1, and their validity is investigated both theoretically and by a numerical test.

548.735.4

7643. THE ELEMENTARY POSITIONAL PROBABILITY OF ATOMS. E.F.Bertaut.

Acta cryst., Vol. 11, Pt 6, 405-12 (June, 1958). In French.

When nothing is known about a structure, the elementary positional probability of atoms is the elementary hypervolume of coordinates $dx \ldots dx_t$. If any information about the structure is gained (interatomic distances, forbidden volumes, known signs of structure factors), the positional probability has the more complete form $\psi(x_1, \ldots, x_t)dx_1 \ldots dx_t$. $\psi(x_1, \ldots, x_t)$ is Fourier-analysed in its most general form, for which some examples are given.

548.735.4

7644. A CRITERION FOR TERMINATING THE REFINEMENT OF AN ATOMIC STRUCTURE. S.Caticha-Ellis and A.Rimsky.

Acta cryst., Vol. 11, Pt 7, 481-4 (July, 1958). In French.

It is assumed that for any structure in a definite state there exists a set of ideal values of structure factors, i.e. without errors, which are not, of course, accessible to measurement. Both the calculated and observed sets of structure factors should be two equally good approximations to the ideal set. This condition provides a criterion for the termination of the process of refinement. In fact it is simpler to compare the discrepancy between the calculated and the ideal set with the experimental error. The first one can be expressed in a simple way in terms of the linear correlation factor r. Independently of the main argument it is shown that the accidental errors are unimportant provided that the number of data collected is high. In this case the limit to the process of refinement is given by the systematic errors, for whose estimation a method is proposed. An outcome of this reasoning is an argument favouring the adoption of the linear correlation factor r for the evaluation of a crystal structure, since it is simply related to the error in the structure.

548.735.4

7645. JOINT PROBABILITY DISTRIBUTIONS OF STRUCTURE FACTORS AND THE PHASE PROBLEM. A.Klug.

Acta cryst., Vol. 11, Pt 8, 515-43 (Aug., 1958).

A method is derived for calculating the joint probability distribution of any desired set of structure factors. The expressions are obtained in the form of a strictly asymptotic series in powers of $N^{-1/2}$ in the case of N equal atoms in the unit cell, and in terms of related quantities in the more general case. The results are thus more accurate than those of Hauptman and Karle, Cochran and Woolfson and Bertaut, and are cast in such a way that it is easy to make a connection between the statistical approach to the phase problem and the underlying physical basis of the sign relations that have been used. In particular, the dependence of the reliability of the latter on the number of atoms in the unit cell is brought out directly. The method is used to make a detailed study of the sign relation between E_{2h} and $|E_h|$ in space group $P\bar{1}$, since this is the prototype of all relations in which signs are determined from intensities. This example is also used to illustrate a general method for determining the mean and higher moments of a structure factor as a function of the values of other related structure factors. A thorough study is made of the sign relationship $S(h) \approx S(h')S(h+h')$ and of Sayre's equation, and a critical assessment given of the value of various relations or formulae that have been proposed for sign determination. The idea of an order of a sign relation is introduced and related to the variance of the estimate of a sign. The advantages claimed for using a formula having strict, rather than merely statistical, validity are disputed and illustrated by a study of the relation between $S(2h + h')$ and the values of $|E_h|$ and $E_{h'}$. A new and more realistic formula is proposed which includes the dependence of $S(2h + h')$ on the known value of $|E_{2h}|$. It is concluded that there is as yet no routine solution of the phase problem, and that the high-order formulae are not useful for anything but the simplest structures.

548.735.4

7646. ON SOME ERRORS IN X-RAY ANALYSIS. I. SYSTEMATIC ERRORS IN OBSERVED STRUCTURE FACTORS. F.Jellinek.

Acta cryst., Vol. 11, Pt 10, 677-9 (Oct., 1958).

Systematic errors in F_0 may be due to, for example, extinction or inaccurate absorption corrections. It is shown that the influence of these errors can be largely suppressed and that in principle they can be corrected for by a modification of the difference-synthesis method. Some examples are given of applications to organic structures containing a heavy atom. Finally it is shown how the enhancement of weak reflections by double reflection can be recognized.

548.735.4

7647. CALCULATION OF GEOMETRICAL STRUCTURE FACTORS FOR SPACE GROUPS OF LOW SYMMETRY. III.

E.W.Radoslovich.

Acta cryst., Vol. 12, Pt 1, 11-13 (Jan., 1959).

For Pt II, see Abstr. 9266 (1955). Describes a simple calculator for functions such as $\cos(hx + ky).\cos lz$. Values of these functions may be readily read off from suitably arranged tables of $\cos hx.\cos lz$ after a simple mechanical shift of origin by an amount ky.

548.735.4

7648. AN IMPROVED METHOD FOR DETERMINING THE RELATIVE POSITIONS OF MOLECULES.

C.A.Taylor and K.A.Morley.

Acta cryst., Vol. 12, Pt 2, 101-5 (Feb., 1959).

The molecular-location method described by Taylor (Abstr. 1363/1955) has been found to fail under certain conditions. The method described in the present paper was designed to overcome these limitations and proves to be more satisfactory in other respects as well; it involves no approximations and the results are presented in the form of a contoured graph which is easier to assess than the pattern of bands produced in the earlier method.

548.735.4 : 536.413

7649. UNIT CELL AND THERMAL EXPANSION OF β-PLUTONIUM METAL. W.H.Zachariasen and F.H.Ellinger.

Acta cryst., Vol. 12, Pt 3, 175-6 (March, 1959).

β-Pu is monoclinic body-centred with 34 atoms per unit cell. At 190°C, $a = 9.284$, $b = 10.463$, $c = 7.859$ A, $\beta = 92.13°$ and the density is 17.70 g cm^{-3}. Preliminary values are reported for the thermal expansion coefficients.

548.735.4 : 538.27

CRYSTAL STRUCTURE ANALYSIS BY NUCLEAR MAGNETIC RESONANCE. See Abstr. 7194

548.736.1

7650. X-RAY INTEGRATED INTENSITY OF GERMANIUM EFFECT OF DISLOCATIONS AND CHEMICAL IMPURITIES.

B.W.Batterman.

J. appl. Phys., Vol. 30, No. 4(1), 508-13 (April, 1959).

The absolute values of X-ray integrated intensities from germanium single crystals were measured with CuK_α radiation. Dislocation densities below 10^5 cm^{-2} did not significantly affect intensities for the first three orders of (111). The observed absolute intensities of all reflections agreed with the prediction of the Darwin—Prins theory within the estimated errors of the measurements and the theoretical calculations. To investigate the effect of chemical impurities on intensities, crystals with one part in 10^4 of indium or lithium atoms and less than 10^5 dislocations/cm^2 were studied. Regions of the indium doped specimen had (444) intensities 30% higher than the high resistivity specimens, while the crystals in which lithium had precipitated gave an increase of about 40% for this reflection. The precipitated lithium broadened the reflection curves and produced a diffuse scattering in the neighbourhood of the Bragg reflection. It is presumably the strains caused by the impurity atoms that are responsible for the increased intensity.

548.736.1

7651. X-RAY MEASUREMENT OF THE DISTRIBUTION OF ELECTRONS IN IRON AND COPPER. R.J.Weiss and J.J.DeMarco.

Phys. Rev. Letters, Vol. 2, No. 4, 148-9 (Feb. 15, 1959).

The X-ray measurements of Batterman (Abstr. 5258/1959) wer repeated on the same samples of powdered Fe and Cu and the experimental results were found to be about the same. However, whe corrections were made for extinction and a measured Hönl correcti was applied the results gave a value of 2.5 ± 1.5 for the number of 3d electrons in Fe relative to Cu, compared with the value of 6.2 ± 0.4 obtained by Batterman. The authors believe that all possible sources of error present in X-ray powder measurements are not yet understood and that the results obtained from such measurements cannot as yet be taken seriously. J.Thewli

548.736.1 : 537.531.85

INTERFERENCE PHENOMENA WITH COMPTON SCATTERIN IN DIAMOND. See Abstr. 7051

548.736.3 : 538.

7652. THE STRUCTURES OF THE CHROMIUM SULPHIDES.

F.Jellinek.

Acta cryst., Vol. 10, Pt 10, 620-8 (Oct., 1957).

The system Cr—S has been studied at room temperature. In the range $CrS_{0.95}$—$CrS_{1.50}$ — previously thought to be a berthollide ange — six phases, each with a narrow homogeneity range, were stablished: namely, monoclinic CrS, trigonal "$\mathrm{Cr_7S_8}$", trigonal $\mathrm{r_5S_6}$, monoclinic $\mathrm{Cr_3S_4}$, trigonal $\mathrm{Cr_2S_3}$ and rhombohedral $\mathrm{Cr_2S_3}$. The ructure of CrS is intermediate between the NiAs and PtS types. $\mathrm{Cr_7S_8}$" probably has a partly disordered structure intermediate be- veen the NiAs and $\mathrm{Cd(OH)_2}$ types. The structures of the other uromium sulphides are also intermediate between those of NiAs and $\mathrm{d(OH)_2}$, but the lattices are completely ordered. $\mathrm{Cr_5S_6}$ is ferri- agnetic within a limited temperature range; at 5° C the magnetic nisotropy is found to be of negative sign. The magnetic properties structures related to the NiAs type are discussed in connection ith geometrical aspects. It is suggested that in the chromium sul- uides both ionic Cr—S bonds and metallic Cr—Cr bonds are present.

548.736.4 : 536.413.2

THERMAL EXPANSION OF CUBIC BARIUM TITANATE. ee Abstr. 6834

548.74

53. A METHOD OF ELIMINATING THE PRIMARY EX- INCTION EFFECT IN ELECTRON DIFFRACTION.

.Honjo and N.Kitamura.

cta cryst., Vol. 10, Pt 8, 533-4 (Aug., 1957).

The method is based on Blackman's theory of primary extinc- on (Abstr. 4673/1939) and depends on measurements of intensities a series of different wavelengths. A.R.Stokes

548.74

54. A METHOD OF CORRECTING THE PRIMARY EX- INCTION EFFECT IN ELECTRON DIFFRACTION. S.Nagakura.

cta cryst., Vol. 10, Pt 9, 601-2 (Sept., 1957).

The method, which uses Wilson's theory of intensity statistics bstr. 7417/1949) is applied to the determination of the structure $\mathrm{Ni_3C}$. A.R.Stokes

548.74 : 537.533

55. THE SCATTERING OF ELECTRONS BY ATOMS AND RYSTALS. I. A NEW THEORETICAL APPROACH.

M.Cowley and A.F.Moodie.

cta cryst., Vol. 10, Pt 10, 609-19 (Oct., 1957).

The scattering of electrons by three-dimensional potential elds, and, in particular, the potential fields associated with a crys- l lattice, is considered in terms of the new approach to physical tics recently proposed by Cowley and Moodie. The three-dimen- onal potential field is approximated by a large number of closely aced two-dimensional potential distributions. An expression is obtained for the wave-function on an arbitrary plane of observation for a point source of electrons at a finite distance or at infinity (parallel irradiation). Particular cases considered are the wave-function at the exit surface of a crystal, corresponding to the image produced by an ideal electron microscope, and the diffraction pattern, or angular scattering function, of a crystal. Two methods of approximation to the general expressions are discussed. In the first the wave-function on the plane of observation is expressed as the sum of the contributions of electron waves scattered 1, 2, ..., n, ... times. The contribution from singly scattered waves is shown to be equivalent to the amplitude distribution given by the usual kinematic theory of scattering. The second method of approximation corresponds to the successive increase in the number of two-dimensional distributions by which the three-dimensional potential field is approximated. It is shown that for the special case, in which only the incident beam and one diffracted beam have appreciable amplitude in the crystal, the present theory gives essentially the same result as the dynamical theory of Bethe. The present theory is particularly suited to the study of the diffraction of electrons by very thin crystals and crystals containing imperfections.

548.74

7656. THE DOUBLE CIRCULAR-DISC SECTOR USED FOR ELECTRON DIFFRACTION. M.Takagi.

Acta cryst., Vol. 10, Pt 11, 708-9 (Nov., 1957).

Two circular metal discs touch each other, and are rotated about their point of contact. This is used to reduce the intensity on electron-diffraction photographs at the centre relative to the outside. It is easy to machine it accurately. A.R.Stokes

548.74

7657. NEUTRON MAGNETIC SCATTERING FACTORS IN THE PRESENCE OF EXTINCTION. S.Chandrasekhar and R.J.Weiss.

Acta cryst., Vol. 10, Pt 9, 598-9 (Sept., 1957).

The use of polarized neutrons for determining the effect of extinction is suggested. [cf. use of polarized X-rays: Chandrasekhar, Acta cryst., Vol. 9, Pt 11, 954 (Nov., 1956)]. A.R.Stokes

548.74 : 539.2

INFLUENCE OF ANHARMONIC OSCILLATIONS OF NUCLEI IN NEUTRON DIFFRACTION STUDIES. See Abstr. 7490

548.74 : 538.2

EXTINCTION EFFECTS IN NEUTRON SCATTERING FROM SINGLE MAGNETIC CRYSTALS. See Abstr. 7163

GEOPHYSICS

55

58. THE DAY-TO-DAY COORDINATION OF I.G.Y. BSERVATIONS. A.H.Shapley.

roc. Inst. Radio Engrs, Vol. 47, No. 2, 323-7 (Feb., 1959).

The I.G.Y. World Days and Communications programme has ur facets: (1) an I.G.Y. Calendar of selected days for experiments nich cannot be carried on continuously; (2) a scheme for specifying riods when phenomena of unusual interest are anticipated a few urs in advance; (3) the prompt and wide distribution of summary servations of outstanding solar and geophysical events; and (4) the e of the world-wide scientific communications network for ocessing information of temporal interest. This is a cooperative fort including all the countries participating in the I.G.Y. The per describes the plan and its execution, including the arrange- ents for rapid communications.

550.312 : 531.261.3

MAXIMUM GRAVITY EFFECT OF CERTAIN SOLIDS OF EVOLUTION. See Abstr. 6562

550.34

59. THE RESPONSE OF SEISMOMETERS IN SERIES AND ARALLEL CONNECTIONS. A.J.Seriff.

eophysics, Vol. 24, No. 1, 49-63 (Feb., 1959).

Two similar seismometers connected in series with a load hibit two independent or "normal" modes of motion. In the first ode the two coils move so that the voltages generated are almost ual and in phase, producing a large current in the circuit and nsiderable damping of the motion. This is the mode normally considered in designing the external damping circuit for series seismometers. In the second mode the coils move nearly 180° out of phase, produce a relatively small current in the circuit, and, consequently, experience very little damping in addition to their open circuit damping. Strong initial excitation of this mode can produce a sustained oscillation damaging to later parts of the seismic record. The usual mathematical description of this system, i.e. two harmonic oscillators coupled through their damping terms, readily yields approximate expressions for the size and damping of the load current in the case of nearly identical seismometers with little internal damping. For example, two such seismometers connected to a load producing large damping for the first mode will exhibit a damping of only $(\omega_1 - \omega_2)^2/4\omega f$ in the second mode. Here ω_1 and ω_2 are the angular frequencies of the two separate seismometers, ω is the average angular frequency, and f is the fraction of critical damping for the first mode. Two seismometers connected in parallel can have considerable electromagnetic damping in both modes of oscillation. For n seismometers in series, there are n − 1 modes which may be poorly damped. The frequencies of these modes are distributed so that one lies between each adjacent pair of the original uncoupled frequencies. The damping in each mode is of the order of $n(\omega_k - \omega_{k+1})^2/8\omega f$. The steady-state characteristics can be readily examined using the seismometer equivalent circuits. The result is strongly dependent on the mode of excitation. For example, if two similar seismometers are connected in series but only one is excited, the frequency characteristic shows both a maximum near the r.m.s. of the two seismometer frequencies and a minimum at the frequency of the seismometer not excited.

550.341 : 534.2

7660. AN EXPERIMENTAL INVESTIGATION OF FACTORS AFFECTING ELASTIC WAVE VELOCITIES IN POROUS MEDIA. M.R.J.Wyllie, A.R.Gregory and G.H.F.Gardner.
Geophysics, Vol. 23, No. 3, 459-93 (July, 1958).

An experimental investigation has been made of the factors which affect the velocity of vibratory signals in porous media. It is shown from the results of experiments carried out on appropriate natural and synthetic porous systems that the time-average formula previously suggested by Wyllie, Gregory, and L.W.Gardner (1956), is of considerable utility. This formula states that

$$\frac{1}{V_M} = \frac{\phi}{V_F} + \frac{1-\phi}{V_R}$$

where V_M = velocity measured, V_F = velocity in saturating liquid, V_R = velocity in rock solid, and ϕ = volumetric porosity fraction. The effects are examined of differential compacting pressures on the applicability of this formula to consolidated and unconsolidated rocks. It is shown that the time-average relationship cannot be applied to determine the total volumetric porosity of carbonate rocks which are vugular and fractured. In such rocks, paradoxically, this circumstance may be advantageous because of the lithological information that may be obtained from an appropriate combination of velocity and nuclear log data. The effects of oil and gas saturation on velocity have been examined experimentally and are found to be comparatively minor. The combination of velocity data with information from electric logs in order to locate zones of oil and gas saturation is shown to be generally valuable; this is particularly so when holes are drilled with oil-base mud. Some discussion is given of the possible effects on velocity measurements of the relative wettability of rock surfaces by various liquids. Owing to instrumental limitations, it cannot necessarily be assumed that measurements made in the laboratory are directly applicable to the interpretation of velocity data obtained under field conditions.

550.38 : 538.1

7661. MAGNETIC FIELD OF THE EARTH. T.G.Cowling.
Nature (London), Vol. 183, 937-8 (April 4, 1959).

The model of Herzenberg is discussed in the light of advantages gained by his mathematical approach to the convergence problem in dynamo theory. S.J.St-Lorant

550.38

7662. ROCK MAGNETISM. S.K.Runcorn.
Science, Vol. 129, 1002-12 (April 17, 1959).

Review article. The magnetization of ancient rocks and questions of polar wandering and continental drift.

550.389 : 537.591.5

GEOMAGNETIC FIELD DISTRIBUTION. SURVEY OF COSMIC-RAY NEUTRON INTENSITY DISTRIBUTION. See Abstr. 7139

550.839 : 538.1

FIELD OF AN ALTERNATING MAGNETIC DIPOLE ON THE SURFACE OF A LAYERED EARTH. See Abstr. 7147

550.389 : 538.1

7663. MAGNETIC DIPOLE NOMOGRAMS. C.E.Price.
Geophysics, Vol. 24, No. 2, 330-4 (April, 1959).

Two nomograms are presented for the solution of the magnetic-dipole equations for magnetic intensity over a dipping dipole

$$\Delta z = -m(d_1/r_1^3 - d_2/r_2^3) \text{ and } \Delta h = -m(e_1/r_1^3 - e_2/r_2^3).$$

The two charts are used in conjunction with each other and are as accurate as is needed for field work. One of these charts will be found useful also in other calculations involving d/r^3.

550.831

7664. A NOTE ON TEMPERATURE COMPENSATION IN GRAVIMETERS. J.Singh.
Sci. and Culture, Vol. 24, No. 9, 429-31 (March, 1959).

ATMOSPHERE . IONOSPHERE

551.5 : 5

SPACE RESEARCH. See Abstr. 6439

551.510.

7665. DENSITY OF THE UPPER ATMOSPHERE. G.Grimminge
Nature (London), Vol. 183, 811-12 (March 21, 1959).

Values derived from satellite data for the density of the upper atmosphere, are shown to be in good agreement with theoretical pr dictions previously put forward by the author. H.J.A.Chiver

551.510.3 : 525.

IRREGULARITIES IN THE DENSITY OF THE UPPER ATMOSPHERE, FROM OBSERVATIONS OF EARTH SATELLITE ORBITS. See Abstr. 6472-3

551.510.

7666. THE CONSTITUTION AND COMPOSITION OF THE UPPE ATMOSPHERE. M.Nicolet.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 142-7 (Feb., 1959).

A general survey is made of various observations and theoretical possibilities which concern the problems involved. The basic problem of the composition of the homosphere and heterosphere is studied after considering the nature of dissociation processes and vertical transport by diffusion. Finally, the effect of thermal conduction on the temperature distribution is shown to be importance over the entire thermosphere above the E layer.

551.510.

7667. THE DISSOCIATION OF OXYGEN IN THE UPPER ATMOSPHERE. M.Nicolet.
Arch. Meteorol. Geophys. Bioklimatol. A, Vol. 10, No. 4, 301-4 (19
In French = Contrib. Inst. Roy. Meteorol. Belgique, No. 45 (1958).

An aeronomic study of departures from photoequilibrium conditions in the lower thermosphere shows that the peak of atomic oxygen concentration occurs in the neighbourhood of 90 km. Its vertical distribution must be associated with the airglow emission at 5577 A and the low temperatures above the mesopause.

551.510.

7668. ABUNDANCE OF NITROUS OXIDE IN GROUND-LEVEL AIR. J.W.Birkeland and J.H.Shaw.
J. Opt. Soc. Amer., Vol. 49, No. 6, 637-8 (June, 1959).

The abundance of nitrous oxide in ground-level air at Columb Ohio, was measured by comparing the absorption of the P-branch the 4.5-μ N_2O band in atmospheric spectra, taken over a 706-mete path, with the corresponding absorptions by known amounts of N_2O. The atmospheric absorption was found to correspond to a nitrous oxide abundance of 0.27 ± 0.05 p.p.m. No variation in abu dance was detected over a 3-month period.

551.510.

7669. EXPLORATION OF THE UPPER ATMOSPHERE WITH T HELP OF THE THIRD SOVIET SPUTNIK. V.I.Krassovsky.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 289-96 (Feb., 1959).

The creation of the Soviet artificial sputniks of the earth, and the physical questions to be investigated by them are first discuss The instruments used on the third sputnik and the problems solve with them are then described; the results obtained are presented simultaneously.

551.510.5

7670. SIZE OF IRREGULARITIES IN THE E REGION OF THE IONOSPHERE. M.Srirama Rao.
Canad. J. Phys., Vol. 37, No. 5, 557-68 (May, 1959).

Three-station fading records taken at Ottawa on frequencies ranging between 2.0 and 2.6 Mc/s were analysed to determine the E-region wind velocities (V) and frequencies of fading (N) for the period June 1953 to April 1955. An empirical relation V = 2.41 N was deduced, on a statistical basis, to represent the above observations. In this equation, λ represents the wavelength of operation. The constant of proportionality (K) in this relation was studied comparatively for three different locations in the northern hemisphere. This constant was related to a characteristic length L which specifies the horizontal size of the irregularities in the E region of the ionosphere by the equation: $L = (1/2) K\lambda$. Variation of this size with latitude is discussed.

551.510.535 : 523.78

7671. VERTICAL IONOSPHERIC SOUNDINGS AT AHMEDABAD [23°N, 72.6°E] DURING THE PARTIAL SOLAR ECLIPSE OF 19 APRIL 1958. R.G.Rastogi.
J. sci. industr. Res., Vol. 18A, No. 3, 123-6 (March, 1959).

The changes in the ionospheric layers are described. The critical frequencies of the F2 layer show a large depression during the eclipse compared with control days. The E and E2 layers show effects similar to the F2 layer, but much feebler. The changes in the F2 layer were found to be mainly due to the lowering of the layer peak. The changes in the F2 layer during this eclipse are compared with those of other solar eclipses which occurred in the forenoon hours.

551.510.535 : 621.396.821

7672. OCCURRENCE OF GIANT TRAVELLING IONOSPHERIC DISTURBANCES AT NIGHT. L.H.Heisler.
Nature (London), Vol. 183, 383-4 (Feb. 7, 1959).

Large travelling disturbances, tracked over distances exceeding 3000 km and previously thought to be confined to daylight hours, have now been detected in F-layer ionograms taken in Australia at night. The simpler ionospheric conditions prevailing at night should help in the elucidation of this phenomenon. G.M.Brown

551.510.535

7673. EFFECT OF MAGNETIC ACTIVITY ON DRIFTS OF THE F2 REGION.
B.Ramachandra Rao, E.Bhagiratha Rao and Y.V.Ramana Murty.
Nature (London), Vol. 183, 667-8 (March 7, 1959).

Contrary to the results obtained at higher latitudes, it is found that at Waltair (9°N), the F2-region drift speeds decrease linearly with increasing K-index. H.J.A.Chivers

551.510.535

7674. THE NORMAL F REGION OF THE IONOSPHERE.
D.F.Martyn.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 147-55 (Feb., 1959).

The global morphologies of the F_1 and F_2 regions at magnetically quiet times are reviewed, and attention also is given to the sunspot-cycle variations. The physical conditions, temperature, pressure, recombination coefficients, and collision frequencies are reassessed in the light of recent studies of rocket and satellite results and of diffusion. The theory of the F region is reviewed with special attention to Bradbury's hypothesis and to the effects of transport of ionization. Also considered are the morphology of "spread-F" and radio star scintillation phenomena. A theory of the latter is outlined and it is shown that the undersurface of the F region is unstable at times of upward drift, which appear to be the times when such phenomena are prominent.

551.510.535

7675. THE NORMAL E REGION OF THE IONOSPHERE.
E.V.Appleton.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 155-9 (Feb., 1959).

The E layer is situated in the middle ionosphere; its lower boundary is at a level of about 100 km when the sun is vertical. Its maximum ionization density is of the order of 10^5 electrons per cm^3 but this varies by about 50 to 60% in the course of the sunspot cycle. The production of ionization in the E layer is due to solar photons, most probably of X-ray character. The disappearance of electrons in the E layer is by way of dissociative recombination between electrons and positive molecular ions. E-layer morphology is influenced to a slight extent by horizontal currents flowing in it across the horizontal geomagnetic field; in other words, the E layer is a motor. It is generally considered that such currents are produced by dynamo action in the E layer due mainly to a diurnal horizontal tidal motion of the conducting medium across the earth's vertical magnetic force. The rough parallelism of the intensity of these horizontal currents with E-layer conductivity during the sunspot cycle suggests the simple result that the diurnal horizontal motion itself does not vary substantially with solar activity.

551.510.535

7676. THE NORMAL D REGION OF THE IONOSPHERE.
J.J.Gibbons and A.H.Waynick.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 160-1 (Feb., 1959).

The general theory of low-frequency sounding in the lower ionosphere is discussed in order to indicate the radio transmission characteristics which a D-layer model must satisfy. D layers based on the fundamental physical processes from 60 to 90 km, which have been presented up to now, have not been completely satisfactory. There is indication that the more accurately determined values of fundamental parameters now available, such as reaction rates, will lead to a more satisfactory model.

551.510.535

7677. THE DISTRIBUTION OF ELECTRONS IN THE IONOSPHERE. J.O.Thomas.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 162-75 (Feb., 1959).

This paper describes the methods now available for calculation from observed virtual height-frequency records. Particular emphasis is given to recently developed machine and manual methods which make it practicable to produce electron distributions on a rapid, routine basis. Attention is drawn to the importance of these data for the physics of the ionosphere by quoting from the results of some existing surveys.

551.510.535

7678. MOTIONS IN THE IONOSPHERE. C.O.Hines.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 176-86 (Feb., 1959).

The ionosphere, even in its "undisturbed" state, is constantly in motion. Its charged and uncharged constituents may travel together or independently, while irregularities in the distribution of charge may take a different course again. The pertinent observational data are extensive and, in some cases, conflicting; their interpretation is seldom direct. The theoretical factors affecting that interpretation are becoming clear, though in some cases their areas of relevance are still subject to divergent opinions. An attempt is made here to bring into focus the theoretical factors themselves, to record their bearing on the observations wherever it has been established, and to suggest paths of future progress wherever it has not. Details of observational results and theoretical developments are largely suppressed, and with them the conflicts and discrepancies which, however real, would obscure the presentation of the principles involved.

551.510.535

7679. METEORS IN THE IONOSPHERE.
L.A.Manning and V.R.Eshleman.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 186-99 (Feb., 1959).

When meteors enter the lower E region of the ionosphere, they produce trails of ionization. Sensitive radio systems at frequencies of 3 to 300 Mc/s can record echoes from these ionized trails at rates of thousands per hour. Study of these echoes has benefited astronomy, the physics of the upper atmosphere, and radio communication. This paper presents a review of the nature of meteoric echoes, and describes the principal uses of meteors as research tools. Some of the directions in which further meteoric research may prove profitable are suggested as well. When the results of the IGY programmes are correlated, we may expect the knowledge gained from the study of meteors to play an important role.

551.510.535

7680. THE F REGION DURING MAGNETIC STORMS.
K.I.Maeda and T.Sato.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 232-9 (Feb., 1959).

The results are described of statistical investigations. The characteristics of the daily variation of the deviation from the mean critical frequency and of the height of the maximum electron density, Δf_0F_2 and Δh_pF_2, respectively, are shown over the wide range of latitude from the equator to the auroral zone and for the principal seasons of the year. After a brief survey of theories to interpret the observed results, it is shown that the ionization-drift theory, which is associated with the dynamo theory, is almost satisfactory for the consistent interpretation of the various facts observed.

551.510.535 : 537.591.5

7681. ABNORMAL IONIZATION IN THE LOWER IONOSPHERE ASSOCIATED WITH COSMIC-RAY FLUX ENHANCEMENTS.
D.K.Bailey.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 255-66 (Feb., 1959).

This is discussed mostly in terms of the great solar event of February 23, 1956. Two kinds of abnormality were recognized: early effects observable in the dark hemisphere at the time of the sudden cosmic-ray enhancement, and late effects which began gradually and reached a maximum a few hours after the cosmic-ray enhancement. The late effects died away over a period of several days in geomagnetic latitudes above 70°, but more rapidly in lower latitudes. Both effects were more intense in higher geomagnetic latitudes. Early effects, though much the less intense of the two, appear to have been observable in lower geomagnetic latitudes than the late effects. The early effects are explained as a consequence of a plausible difference in composition between streams of solar particles of cosmic-ray energies, and ordinary cosmic rays. The late effects are explained in terms of ionization produced in the lower ionosphere (the range of height from 30 to 110 km is studied) by the passage or stopping of solar particles — mostly protons. Such particles are shown, like the more energetic solar cosmic rays, to be arriving essentially isotropically after the maximum effects occur. A plausible extension of the observed magnetic-rigidity spectrum of the solar cosmic rays downward in rigidity by about a power of 10 would provide the protons necessary to account for the observations. The absence of auroral and significant magnetic activity accompanying the abnormal ionization is consistent with the explanations offered. Moreover, certain more recent high-latitude absorption events, unaccompanied by ground-level cosmic-ray flux enhancements, are explicable in similar terms. An interesting by-product of the investigation is a provisional evaluation not only of the coefficient of collisional detachment of electrons from negative ions, probably mostly O_2^- , but also of the negative-ion-to-electron ratio and the effective recombination coefficient at night between 30 and 110 km.

551.510.535 : 525.3

7682. EARTH SATELLITE OBSERVATIONS OF THE IONOSPHERE. W.W.Berning:
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 280-8 (Feb., 1959).

A number of so-called "First Generation" experiments for exploring the ionosphere with artificial earth satellite vehicles has either been carried out or is planned by the United States and the Soviet Union. The theoretical and experimental bases of these experiments are outlined and discussed, and their limitations emphasized. The first available results are from the Soviet experiments and these are discussed. Finally, a brief consideration is given to the kinds of satellite orbits desirable for ionospheric experiments.

551.510.535 : 621.396.8

7683. AUTOMATIC SWEEP-FREQUENCY IONOSPHERE RECORDER, MODEL C-4. J.N.Brown.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 296-300 (Feb., 1959).

The equipment includes improvements in output power, receiver sensitivity, purity of output signal, and other details, over earlier equipments. The basic principles of operation are described and the transceiver-type of circuitry explained. The operating characteristics are: frequency range, 1-25 Mc/s; output power, 10-30 kW peak pulse power; pulse length, 50 μsec; repetition rate, variable from 10-70 pulses per second. An elaborate control and programming system is provided which can be used to operate the equipment on an unattended automatic basis. The "virtual height" of the ionospheric layers, as a function of frequency, is recorded on photographic film by two cameras — a 35 mm uniformly-moving-film unit, and a frame-by-frame 16 mm camera, which produces time-lapse motion pictures of the changes which occur. A brief history of the development of the sweep-frequency recorder technique is given.

551.510.535 : 621.396.8

7684. THE I.G.Y. THREE-FREQUENCY BACKSCATTER SOUNDER. A.M.Peterson, R.D.Egan and D.S.Pratt.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 300-14 (Feb., 1959).

Design criteria and operating characteristics are outlined. This three-frequency (12, 18, and 30 Mc/s) rotating-antenna pulse sounder was designed at Stanford University for oblique-incidence ionosphere studies. During the I.G.Y. a network of these sounders was operated at thirteen stations in polar, temperate, and equatorial regions. Data reduction and publication of data summaries were carried out at Stanford using semiautomatic punch card methods. Preliminary analysis of data has yielded new information on sporadic-E, magnetic field aligned irregularities, large-scale travelling disturbances in the F region, and the effects of ionospheric tilts on long-distance propagation.

551.510.535 : 621.396.8

7685. THE RIOMETER — A DEVICE FOR THE CONTINUOUS MEASUREMENT OF IONOSPHERIC ABSORPTION.
C.G.Little and H.Leinbach.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 315-20 (Feb., 1959).

A sensitive, self-balancing, noise-measuring equipment, known as the riometer, is described. This instrument was designed for routine measurement of ionospheric absorption during the I.G.Y. using the cosmic noise method. Application of this technique in the auroral zone has resulted in quantitative measurements of ionospheric absorption, even during polar blackouts. The riometer has the advantages over a simple total-power cosmic noise receiving system of (1) linear response to changes of input noise power; (2) high accuracy in the presence of narrow-band r.f. interference; and (3) good long-term stability.

551.510.535 : 538.561

VERY LOW-FREQUENCY EMISSIONS GENERATED IN THE EARTH'S EXOSPHERE. See Abstr. 7213

551.510.535

RADIO-WAVE PROPAGATION IN THE IONOSPHERE. See also the Section entitled "ELECTROMAGNETIC WAVES AND OSCILLATIONS".

551.510.536

7686. GEOPHYSICAL EFFECTS ASSOCIATED WITH HIGH-ALTITUDE EXPLOSIONS.
P.J.Kellogg, E.P.Ney and J.R.Winckler.
Nature (London), Vol. 183, 358-61 (Feb. 7, 1959).

A mechanism is discussed whereby it should be possible to release Van Allen radiation (normally trapped in the magnetic field of the earth at great heights) following distortion of the magnetic field by the kinetic energy of a high altitude explosion. Possible geophysical effects of such a phenomenon include the production of aurorae, magnetic disturbances at the surface, ionospheric changes, and the production of an artificial whistler. The geomagnetic disturbances observed at Apia following the Johnston Island nuclear explosion (Aug. 1, 1958) are considered to be due directly to the injection of charged particles from such an explosion, rather than to the release of trapped radiation, but geophysical effects following high altitude chemical explosions could result from the release of natural radiation. G.M.Brown

551.521.326

7687. ORIGIN OF UPPER-ATMOSPHERE LITHIUM ATOMS RESPONSIBLE FOR THE NEW TWILIGHT AIRGLOW AT 6708 A.
D.R.Barber.
Nature (London), Vol. 183, 384 (Feb. 7, 1959).

Taking account of the recent observations of Dellanoy and Weill, and of Gadsden and Salmon (Abstr. 1959, 1960, 4148 of 1959), evidence is presented which suggests that the Li atoms were liberated at the time of a high-altitude detonation of a nuclear device above Johnston Island, Pacific Ocean, on Aug. 1, 1958.
D.R.Barber

551.521.326

7688. THE NIGHT AIRGLOW. F.E.Roach.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 267-71 (Feb., 1959).

A phenomenological description is presented, reviewing the historical background, and what is known about height, temporal and spatial variations in intensity, and movements. The very important relationship to aurora and evidence for latitude-seasonal effects are examined.

551.521.326 : 522.61

BRIGHTNESS STANDARD FOR NIGHT AIRGLOW PHOTOMETERS. See Abstr. 6440

551.521.63

7689. REMARKS ON THE CALCULATION OF THE ULTRA-VIOLET RADIATION FROM A CLEAR SKY. J.Lenoble.
Rev. Opt., Vol. 36, No. 7, 343-56 (July, 1957). In French.

The tables of Chandrasekhar's functions (1954) make available an exact and rapid method for calculating the probable order of magnitude of sky luminance in the range, 3015-3715 A, for different directions relative to the sun, using known values of the primary diffusion. It would be desirable to extend the tables to include higher values of optical density, and also to correct for the effect o absorption by atmospheric O_3. D.R.Barbe

551.521.67

7690. LOW-ENERGY CORPUSCULAR RADIATION AT HIGH LATITUDES. K.D.Cole.
Nature (London), Vol. 183, 738 (March 14, 1959).

Electrostatic waves are assumed to be generated in the exosphere by solar corpuscular streams. It is suggested that the waves are propagated along the geomagnetic field lines, trapping charged particles and accelerating them by a mechanism discussed by Bohm and Gross (Abstr. 4062, 5448/1949), thus giving rise to the observed radiation. W.O.Lock

551.521.9

7691. ORIGIN OF THE RADIATION NEAR THE EARTH DISCOVERED BY MEANS OF SATELLITES. T.Gold.
Nature (London), Vol. 183, 355-8 (Feb. 7, 1959).

The existence of charged particles above the earth (from 600 km upwards) having energies up to several tens of MeV is inferred from recent satellite observations, and also from auroral observations. Assuming that both these particle fluxes are part of the same phenomenon, calculation of the rate at which energy must be fed into the atmosphere shows that the total energy available from cosmic-ray secondaries is quite inadequate. An initially isotropic supply of particles injected into the atmosphere at a great height would interact with the earth's field, leading to various modes of motion, with different time scales. Details of this behaviour are considered in a descriptive manner. G.M.Brown

551.573 : 536.423.8

INFLUENCE OF MONOLAYERS ON EVAPORATION FROM WATER STORAGES. See Abstr. 6839

551.575 : 541.182 : 531.715

7692. DETECTING VOLATILE AIRBORNE DROPLETS. K.R.May.
Nature (London), Vol. 183, 742-3 (March 14, 1959).

A technique has been developed for counting and recording the sizes of fog droplets of diameters down to 1 μ. The droplets impinge on a thin pure gelatin film (optimal thickness about 1 μ) on a slide, and after evaporation, leave a ring of diameter proportional to droplet diameter, which can be viewed with positive phase contrast. A similar technique for sampling kerosene droplets has been developed, using a kerosene-soluble silicone resin film, and in principle droplets of a wide range of volatile liquids can be sampled by using suitable clear soluble films. J.G.Oldroyd

551.576 : 537.221

ELECTRIC CHARGE ON CONDENSATE AND WATER DROPLETS. See Abstr. 6865

551.578.4 : 548.51

ICE-CRYSTAL PRODUCTION BY AEROSOL PARTICLES. See Abstr. 7600

551.590.21 : 537.591.5

COSMIC RADIATION AND THE WEATHER. See Abstr. 7141

551.594.14

7693. THE ABSOLUTE MEASUREMENT OF THE CONCENTRATIONS OF THE RADIOACTIVE SUBSTANCES IN THE ATMOSPHERE, IN TOKYO. M.Kawano and S.Nakatani.
J. Geomagn. Geoelect., Vol. 10, No. 2, 56-63 (1959).

By making a comparison with the already known concentration of radon emanated from the radium standard solution, the absolute measurement of the concentrations was carried out using an ionization chamber. On fine days, the concentrations were $2.3 \sim 12.0 \times 10^{-16}$ c/cm^3. The ratio of the ionization current by beta- and gamma-radiations to that by total radiations in a definite volume of air is about 5 ~ 25%, and is much larger than that in radon, being in a state of radioactive equilibrium with its decay products (the ratio is about 2 ~ 3%).

551.594.14

7694. FISSION PRODUCT RADIOACTIVITY IN THE AIR ALONG THE 80th MERIDIAN — JANUARY-JUNE 1957.
L.B.Lockhart, Jr, R.A.Baus and I.H.Blifford, Jr.
Tellus, Vol. 11, No. 1, 83-90 (Feb., 1959).

Measurements of gross fission product radioactivity in the air at a number of sites along the 80th meridian (west) are reported. The concentration of long-lived radioactive products (primarily fission products) in the air continues to remain considerably higher in the Northern than in the Southern Hemisphere. Among the more interesting developments, there has been obtained a definite inverse relation between the air concentration of radioactivity and rainfall during the dry and rainy seasons at Panama. The use of "radioactivity profiles" (plots of latitude v. fission product concentration) to represent a cross-section of the average air concentrations of fission products along the 80th meridian for any given period offers a ready means to obtain the total burden of such activity in the atmosphere for such a period and to follow its increase or decrease with time.

551.594.14 : 537.591.8

7695. STUDY OF COSMIC RAY PRODUCED SHORT-LIVED P^{32}, P^{33}, Be^7, AND S^{35} IN TROPICAL LATITUDES.
P.S.Goel, N.Narasappaya, C.Prabhakara, Rama Thor and P.K.Zutshi.
Tellus, Vol. 11, No. 1, 91-100 (Feb., 1959).

The fall-out rate of four short-lived isotopes P^{32}, P^{33}, Be^7 and S^{35}, produced in the collisions of cosmic ray particles with air nuclei, was measured at a number of stations in India and compared with the calculated rate of production. In the case of Be^7, the agreement between the calculated and measured values is good. The fall-out rates of P^{32} and P^{33} are not inconsistent with the calculated values; that of S^{35}, however, is about five times higher than expected. The absolute concentrations of an individual isotope in various rain falls were found to vary by more than a factor of forty; relative concentrations of the different isotopes, however, stayed within fairly narrow limits. The ratio of the concentration of the isotope Be^7 to that of the isotope P^{32} in individual rain samples was used to find out the periods for which various air masses had been irradiated in the interval between two successive precipitations. The mean period of irradiation is found to be about thirty-five days. The present results are consistent with the view that, in these tropical latitudes, intrusions of stratospheric air into the troposphere are either rare or weak in intensity. The method seems capable of further development as a tool for studying meteorological problems.

551.594.14 : 537.591.8

7696. ON THE INFLUENCE OF COSMIC RADIATION ON THE ISOTOPIC COMPOSITION OF THE ELEMENTS. S.A.E.Johansson.
Tellus, Vol. 11, No. 1, 101-5 (Feb., 1959).

When cosmic radiation interacts with the atomic nuclei of the atmosphere, it produces a great number of stable as well as radioactive isotopes. The radioactive isotopes are fairly easy to detect but the production of stable isotopes can only be detected by the changes in isotopic composition of the elements that might be caused by this effect. The amounts of Li^6, Ne^{21}, and A^{36} that are produced in this way were calculated. If the mean intensity of cosmic radiation in the past was the same as at present it turns out that the production of these isotopes causes a change in isotopic composition which is barely detectable. A study of this effect gives a possibility of obtaining information about the cosmic-ray intensity in the past. If no cosmic-ray effect is found, it shows that the mean cosmic-ray intensity in the past could not have been considerably higher than at present. If the cosmic-ray intensity during the earlier stages in the earth's evolution were higher than at present, one could expect easily detectable changes in the isotopic composition of some elements.

551.594.14 : 541.182

DETERMINATION OF THE PERIODS OF STABILITY OF AEROSOLS FROM THE RaD AND RaF CONTENT OF ATMOSPHERIC AIR AND ATMOSPHERIC PRECIPITATIONS. See Abstr. 7584

551.594.2 : 538.566.3 : 621.396.821

7697. "WHISTLER MODE" ECHOES REMOTE FROM THE CONJUGATE POINT. R.L.Dowden and G.T.Goldstone.
Nature (London), Vol. 183, 385-6 (Feb. 7, 1959).

Reception of v.l.f. radio pulses (17.4 kc/s) at Hobart after a delay ~0.2 sec following transmission from Tokyo is interpreted as "whistler mode" propagation to somewhere near the geomagnetic conjugate point to Tokyo (around Darwin) followed by earth-ionosphere waveguide propagation to Hobart. Calculations using Storey's equation suggest an electron density $\sim 2 \times 10^4$ cm^{-3} at 1400 km. This experiment demonstrates that it is not necessarily safe to assume that short whistlers originate near one's conjugate point. G.M.Brown

551.594.2

7698. ATMOSPHERIC WHISTLERS.
R.A.Helliwell and M.G.Morgan.
Proc. Inst. Radio Engrs, Vol. 47, No. 2, 200-8 (Feb., 1959).

A general description is given. Their discovery, and the development and proof of a theory to explain them, are reviewed. The I.G.Y. synoptic programme of study is described and examples of results, both individual and statistical, are presented and discussed.

551.594.221 : 523.74

SOLAR ACTIVITY AND WHISTLER DISPERSION. See Abstr. 6456

551.594.5

7699. AN ARTIFICIAL AURORA.
P.H.Fowler and C.J.Waddington.
Nature (London), Vol. 182, 1728 (Dec. 20, 1958).

Since a nuclear bomb explosion 100 miles above Johnston Island could not be seen from the upper atmosphere over Apia (2200 miles distant), at the site of the recently-observed artificial aurora (Abstr 3017/1959), direct radiation from the nuclear device is unlikely to have caused the phenomenon. It is here suggested that charged particles emitted at the time of the nuclear detonation, and guided along the geomagnetic lines of force, were responsible. The particles were most probably β-ray electrons. The long duration of the displa (6-7 min) is accounted for by the long average life-times of the nucl produced by the explosion, and also by the large number of metastab excited atoms decaying with appreciable life-times. D.R.Barber

BIOPHYSICS
PHYSIOLOGICAL PHYSICS

612.014.482.4 : 539.12

7700. SOME RADIOLOGICAL APPLICATIONS OF GAMMA-RAY TRANSPORT THEORY. M.J.Berger and L.V.Spencer.
Radiation Research, Vol. 10, No. 5, 552-70 (May, 1959).

Gamma-ray transport theory is applied to the calculation of energy dissipation in bounded water media under conditions approximating those found in radiological problems. A combination of analytical, numerical, and Monte Carlo techniques is used. Two typical situations are considered: (1) a medium in which an isotropic source of radiation is distributed; (2) a medium irradiated by an external beam of radiation. The spatial pattern of energy dissipation is worked out in detail for a source emitting 1.28 MeV photons. The results of problem 2 are applied to the calculation of the depth dose produced by the irradiation of a medium with Co^{60} beams with cross-sectional areas up to 400 cm^2. The calculated depth-dose distributions are in good agreement with experimental distributions obtained by Johns and collaborators (1952).

612.843.31

7701. SOME MEASUREMENTS ABOUT THE FUSION FREQUENCY OF COLOURS. P.L.Walraven, H.J.Leebeek and M.A.Bouman.
Acta electronica, Vol. 2, No. 1-2, 50-4 (1957-58).

"Physical problems of colour television" Conference paper (see Abstr. 1006/1958). Flicker experiments involved alternating stimulation of a 2° foveal part of the retina (retinal illumination $\cong$1000 trolands, zero surround) with white light and a desaturated spectral stimulus. An exponential law relating purity and fusion frequency was found to hold, the index varying with wavelength. R.A.Weale

612.843.45

7702. EFFECT OF STRIATED FIELDS ON CRITICAL FLICKER FREQUENCY. E.H.Graham and C.Landis.
J. Opt. Soc. Amer., Vol. 49, No. 6, 580-5 (June, 1959).

Critical flicker frequency measurements were obtained as a function of retinal illuminance for a square centrally regarded field (8.5 degrees on a side) containing various numbers of vertical stripes. The visual field contained under the different experimental conditions 0, 10, 30, 90, and 250 black lines per inch, corresponding to an angular subtense at the eye of 0.63, 0.21, 0.07, and 0.025 degree, respectively. Results indicate that CFF decreases with increases in the number of stripes reaching a minimum at approximately 30 stripes per inch, and then may increase with further increases in the number of stripes. Except at the highest illuminances where the curve for the field containing the largest number of stripes (250 per inch) overtakes that of an unpatterned field, all of the striped fields result in lowered CFF v. log retinal illuminance curves when compared with an unstriped field of the same size.

612.843.63

7703. DIRECT MEASURES OF THE RETINAL IMAGE.
D.W.DeMott.
J. Opt. Soc. Amer., Vol. 49, No. 6, 571-9 (June, 1959).

Direct measurement of acuity target images as formed by excised steer and cat eyes indicates the blur of the retinal image to be much greater than theoretically expected. For example, a 3 sec black line produces a retinal image of maximum contrast 0.5%. The author believes the discrepancy between theory and measurement to be due to the neglect, in theoretical calculations, of entoptic stray light. The measured characteristics of the image are discussed in relation to existing data on entoptic stray light, glare, and acuity.

612.844

7704. FACTORS INFLUENCING ACCOMMODATION RESPONSES OF THE HUMAN EYE. F.W.Campbell and G.Westheimer.
J. Opt. Soc. Amer., Vol. 49, No. 6, 568-71 (June, 1959).

Experiments are reported showing that a variety of clues such as chromatic aberration, spherical aberration, or astigmatism may be used to decide whether a monocularly viewed out-of-focus target requires an increase or decrease of accommodation for it to be refocused. When these clues are removed the initial direction of accommodation readjustment may be in error.

612.8

7705. AUDITORY LOCALIZATION OF CLICKS.
B.H.Deatherage and I.J.Hirsh.
J. Acoust. Soc. Amer., Vol. 31, No. 4, 486-92 (April, 1959).

Previous investigations on the auditory localization of sounds have established that interaural differences in time and in intensity are both important. There have also been attempts to set temporal and intensive differences against each other, so that a lead in time at one ear accompanied by an increase in intensity at the other ear would cause a sound to be localized in the midline. On the basis of hypotheses suggested by physiological observations, two experiment were carried out. The first showed that the intensive difference required to offset a difference in time at the two ears depends upon the level of the sounds. Clicks at low level require smaller differences in intensity to offset a given temporal difference than do click at a high level. The relation between intensive differences (decibel and temporal differences (microseconds) is not linear at any of the levels studied. In the second experiment, high-frequency masking noise interfered with reception in the basal turn of the cochlea. Although this noise did not mask the clicks, it produced a temporal lag that required compensation by a time delay at the opposite ear. The relations between these psychophysical results and physiologic findings are discussed.

612.8

7706. SEARCH FOR PHYSICAL CORRELATES TO PSYCHOLOGICAL DIMENSIONS OF SOUNDS. L.N.Solomon.
J. Acoust. Soc. Amer., Vol. 31, No. 4, 492-7 (April, 1959).

Twenty passive sonar recordings were ranked by 50 subjects i terms of their aurally perceived (psychological) characteristics on seven different dimensions. Correlations were run between octave band sound pressure level measurements of the sounds and their rank orders on the seven psychological dimensions. Meaningful relationships were found between ranks on certain psychological dimensions and energy concentration within certain octave bands. Also, an analysis was made of the manner in which the twenty soun clustered within the space defined by the seven psychological dimen sions. Analyses of these sound clusters revealed that the rhythmic beat pattern of the stimulus is a principal attribute upon which sona men base their judgments of "similarity".

612.85

707. AGE AND SEX DIFFERENCES IN PURE-TONE HRESHOLDS. J.F.Corso.

Acoust. Soc. Amer., Vol. 31, No. 4, 498-507 (April, 1959).

In recent years there has been an increased emphasis on medi- olegal problems involving the assessment of hearing loss due to oise exposure. One of the attendant difficulties, however, has been e problem of separating the factors of noise exposure and of age s contributors to hearing disabilities. The present study was per- rmed to determine the normal thresholds of hearing for pure tones r an age-stratified sample of subjects drawn from a population posed to minimal levels of industrial noise. Audiometric meas- rements from 250 to 8000 c/s were made on a total of 500 subjects vided into four age groups: 18 to 24, 26 to 32, 34 to 40, and 43 to years, inclusive. The results of this study indicate that, in gener- , only minor differences (less than 5 dB) exist between the average resholds of right and left ears, but that women have more sensitive earing than men and show less intersubject variability. This sex fference is independent of age and is more marked at the higher fre- encies. For both men and women, there is a decrease in hearing nsitivity with increasing age and a progressive spreading of the ss from the higher to the lower frequencies. Men are more affect- than women, with the hearing loss occurring at an earlier age and oducing a greater degree of auditory impairment. The threshold rves of the present study are considered to yield a more valid timate of the "pure" effects of age on hearing than previously ailable. It is recommended that future audiometric standards be ecified independently for men and for women according to par- cular age levels.

612.85

'08. INTENSIVE DIFFERENTIAL THRESHOLDS FOR OCTAVE AND NOISE. A.M.Small, Jr, W.E.Bacon and J.L.Fozard.

Acoust. Soc. Amer., Vol. 31, No. 4, 508-10 (April, 1959).

This study investigated the effects of 4 band widths of noise of fferent centre frequencies presented at three sensation levels on e size of the differential threshold (ΔI) for intensity. Eleven un- ained subjects and three trained subjects served in a study em- oying the method of limits. Analaysis of the data showed that ΔI's r a low octave band (127-225 c/s) of noise were larger than those r a middle octave band (1040-2080 c/s) and high octave band 080-8160 c/s) of noise. The middle and high bands in turn yielded I's that were larger than those for a wide-band noise. The mag- tude of the ΔI's for the octave noise bands were tentatively related the average ΔI for those frequencies contained in the band. Com- rison of the ΔI's for wide-band noise to those obtained by other perimenters showed close agreement.

612.85

09. INDICES OF SIGNAL DETECTABILITY OBTAINED WITH ARIOUS PSYCHOPHYSICAL PROCEDURES. J.A.Swets.

Acoust. Soc. Amer., Vol. 31, No. 4, 511-13 (April, 1959).

The index of detectability d' was estimated from data collected th various psychophysical procedures, specifically, the forced- oice method with different number of alternatives, and the yes—no ethod. The estimates were, in all instances, quite comparable. is result is comforting in view of the fact that none of the other dices extant provide a unification of data collected with different ocedures. This result is also somewhat surprising in view of the ct that the calculation of d' assumes perfect memory, and forced- oice experiments were conducted with as many as eight temporal ternatives.

612.85

10. MULTIPLE OBSERVATIONS OF SIGNALS IN NOISE. A.Swets, E.F.Shipley, M.J.McKey and D.M.Green.

Acoust. Soc. Amer., Vol. 31, No. 4, 514-21 (April, 1959).

The use of repeated presentations of a given signal event as an perimental technique in psychoacoustic studies provides informa- on about several general properties of the hearing process. From e relationship between the gain in detectability that results from ditional observations and the type of signal and noise employed, ferences can be made about: (1) the observer's ability to integrate er time, (2) the amount of noise generated by the auditory system, the nature of the process of frequency analysis, and (4) the ob- rver's mode of dealing with uncertainty as to signal frequency. e first set of experiments permitted five observations of each gnal where the signal consisted of a pulsed tone, of known frequency, noise. Both variable noise, i.e., noise that is statistically indep- dent from one presentation to another, and constant noise, i.e., noise that is exactly the same on each of the five presentations, were used. With variable noise, the detectability index d' improves, as predicted, as the square root of the number of observations. The use of constant noise, which results in less improvement, provides an estimate of the portion of the total noise affecting detection that is of internal origin. The results under different levels of external noise indicate that internal noise is proportional to external noise. A second set of experiments employed signals whose frequencies were unknown to the observers, and signals comprised of several widely spaced frequencies. Their results are discussed in relation to three alternative models of the process of frequency analysis.

612.85

7711. TEMPORARY THRESHOLD SHIFT FROM OCTAVE-BAND NOISE: APPLICATIONS TO DAMAGE-RISK CRITERIA.
W.D.Ward, A.Glorig and D.L.Sklar.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 522-8 (April, 1959).

The growth and recovery of T.T.S. in normal observers following exposure to octave-band noise is shown to follow the same course as that after broad-band noise: both are linear in log time. Rate of growth varies with frequency of exposure band and test frequency, being greatest at 4 kc/s following exposure to 2400-4800 c/s or 1200-2400 c/s, less at lower test frequencies and octave bands. The time for total recovery apparently is a function of the initial T.T.S. The results support present damage-risk criteria for continuous noise, which (1) suggest ear protection when octave-band levels exceed 85 dB S.P.L. and (2) require it in levels above 95 dB S.P.L.

612.85

7712. RELATION BETWEEN RECOVERY FROM TEMPORARY THRESHOLD SHIFT AND DURATION OF EXPOSURE.
W.D.Ward, A.Glorig and D.L.Sklar.

J. Acoust. Soc. Amer., Vol. 31, No. 5, 600-2 (May, 1959).

Approximately 20 dB of TTS at 3 and 4 kc/s measured 2 min after cessation of the TTS-producing stimulation was produced in 14 normal listeners by three different exposures to 1200- to 2400 c/s noise: to 106 dB SPL for 12 min, to 98 dB for 27 min, and to 90 dB for 117 min. Despite the fact that the TTS produced at other frequencies was different for the three exposures, the courses of recovery at 3 and 4 kc/s were indistinguishable. From these results and those of others, it is concluded that the course of recovery from TTS is uniquely determined by the value of TTS at 2 min recovery: i.e., by the TTS remaining after the first fast recovery process, the so-called R-1 recovery process, has run its course.

612.858

7713. LATENCY OF ACTION POTENTIALS IN THE COCHLEA OF THE GUINEA PIG. B.H.Deatherage, D.H.Eldredge and H.Davis.

J. Acoust. Soc. Amer., Vol. 31, No. 4, 479-86 (April, 1959).

The latency of the well-synchronized whole-nerve action potential (AP) in the cochlea of the guinea pig includes both neural and travelling-wave delays. The latency varies with the intensity and with the frequency of the acoustic stimulus. Selective local interference with the response was produced by (1) selective masking, (2) local fatigue of sensory elements, and (3) local injection of drugs. Such interference in the basal turn prolonged the latency of the AP response. Low-frequency tones can reduce the N_1 response to click stimuli without changing the modal latency. Apparently nearly all of the well-synchronized AP is due to neurons that arise in the first turn of the cochlea, regardless of the frequency of stimulation. The travelling-wave delay appears as a significant component of latency only in the smaller AP responses that remain after the impulses arising in the first turn are suppressed. Information about the time of onset of an acoustic signal can be delivered to the central nervous system primarily by the best-synchronized or modal portion of the AP response.

612.858

7714. BEATS IN COCHLEAR MODELS. J.Tonndorf.

J. Acoust. Soc. Amer., Vol. 31, No. 5, 608-19 (May, 1959).

Beats in cochlear models were studied from two aspects: (1) their effect upon cochlear fluid motion which, occurring along elliptical orbits, essentially represents Lissajous figures. The orbits expanded and contracted synchronously with the beat rate. Thereby, a partial rectification (asymmetrical expansion) became apparent which, occurring in opposite directions in the two scalae across the partition, constituted the beat. This latter phenomenon was caused by the stiffness gradient of the cochlear partition. (2) Their effect upon the travelling wave pattern along the partition was originally described by Békésy. Stroboscopic examination revealed that the beat frequency modulates the two primaries thus producing two additional side bands. However, the displacement pattern of the membrane when viewed by high-speed motion photography did not give any evidence of these five frequencies. Only the intertone (and the beat) was present. It then became apparent that the model is really a pattern analyser of complex sound. In terms of cochlear fluid motion, it is able to resolve complex Lissajous by a spatial filter action along the partition into simple Lissajous. Any deviation from steady Lissajous, which ordinarily result from primaries in relation of integral numbers, produces beats. Thus beats of imperfect unison as well as of mistuned consonances have essentially the same cause: a cyclic phase change between the tw primaries.

613.84 : 531.715 : 541.1

SIZE DISTRIBUTION OF TOBACCO SMOKE PARTICLES. See Abstr. 7583

TECHNIQUE . MATERIALS

621.836 : 531.132

EXACT LINEAR SIMPLE HARMONIC MOTION BY A SPACE-LINKAGE. See Abstr. 6558

666.1

7715. GLASS, A DISTURBING FACTOR IN PHYSICAL ELECTRONICS MEASUREMENTS. D.G.Bills and A.A.Evett.
J. appl. Phys., Vol. 30, No. 4(1), 564-7 (April, 1959).

Evidence was obtained that Pyrex and other glasses are not desirable construction materials in certain types of physical investigations such as clean surface experiments and measurements involving small ion or electron currents produced at low pressures. Pyrex appears to decompose at temperatures above about 350° C liberating water vapour and decomposition products which are not readily pumped out of a vacuum system. Pyrex also appears to chemically sputter in the presence of gaseous ions such as nitrogen or oxygen, thus liberating contamination into the system which is not readily removed. Sodium and potassium were identified among the decomposition products and it is well known that these atoms are desorbed as ions from many metal surfaces when the surface is heated. Thus decomposition and sputtering of glass can produce spurious ion currents under certain conditions. The decomposition products can possibly account for insulating films on metal electrodes which charge up or polarize under charge bombardment.

69 : 53.081

DATA MANUALS FOR URANIUM, THORIUM, NIOBIUM AND VANADIUM. See Abstr. 6479-82

PHOTOGRAPHY

771.5

7716. BRIGHTNESS OF FINE DETAIL IN GROUND PHOTOGRAPHY. P.D.Carman and H.Brown.
J. Opt. Soc. Amer., Vol. 49, No. 6, 629-36 (June, 1959).

For a number of typical outdoor photographic scenes on cloudless days, a statistical study was made of logarithmic brightness and of differences of log brightnesses on adjacent pieces of fine detail, as they would be seen by a representative camera. Values were obtained photographically on Super XX film and also by mean of a photoelectric telephotometer corrected to Super XX spectral response. The results do not disagree seriously with accepted val for the photographic brightness range. However, the uncertainty i the meaning of "brightness range" is illustrated and a definition is proposed for a "99% range." For difference of log brightness on fine detail, low values are found to predominate, with two-thirds o the differences below the average value of 0.15.

LIST OF JOURNALS

The following list supplements the List of Journals published with the Index to Volume 61 (1958). Reprints of the List of Journals can e obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

en. Radio Exper.	General Radio Experimenter. General Radio Company, West Concord, Massachusetts, U.S.A.
riklad. Mat. i Mekh.	Prikladnaya Matematika i Mekhanika. Akademiya Nauk SSSR, Cherkasskii per., 2, Moscow.
roc. Nat. Acad. Sci. India	Proceedings of the National Academy of Sciences of India, Section A (Physical Sciences) and Section B (Biological Sciences). Lajpatrai Road, Allahabad - 2, India.
adio Res. Special Rep. (London)	Radio Research Special Reports. Department of Scientific and Industrial Research, Charles House, 5-11, Regent Street, London, S.W.1.

NEW JOURNAL

. nuclear Mater.	Journal of Nuclear Materials. North-Holland Publishing Company, P.O.Box 103, Amsterdam. Quarterly. Vol. 1, No. 1, dated April, 1959.

ERRATA

Abstr. 6153 (1959) line 6 : for "cm" read "in.".

AUTHOR INDEX

arts,W.H., 6581
eles,B., 6826
rahamson,P., 7279
ramowitz,M., 6822
hor,W.T., 7325
itya,P.K., 7246
anas'eva,N.V., 7502
ao,Y., 7023
der,B.J., 6548
derdice,D.S., 7203
eksandrov,I.V., 7196
exander,G., 7279
fvén,H., 7137
ger,R.S., 7521
khazov,D.G., 7307
lcock,G.McK., 6456
len,C.H., 6651
len, F.G., 6980
len,K.R., 7020
len,R.C., 7341
les,W., 7284
libone,T.E., 7371
lin,E.J., 6725
meida,I.G., 7321
varez,L.W., 7360
naldi,U., Jr, 7243
nati,D., 7288
ndur,I., 6602
derson,E.W., 6596
derson,J.M., 7052
derson,O., 6867
derson,T.H., 7521

Anderson,W.A., 7200, 7439
Andes,G.M., 6585
Andre,P.A., 7547
Andrews,E.H., 7529
Andronikashvili,É.L., 7135
Antonescu,V.I., 6605
Appel,J., 6932
Appleton,E.V., 7675
Aragón,F., 7472
Arase,T., 6635
Arber,H., 6464
Armstrong,B.H., 7312
Arnold,G.P., 6846
Arrott,A., 7150
Arsac,J., 6683
Ascher,E., 6912
Athay,R.G., 6457, 6462
Atkinson,H.H., 7043-4
Atoji,M., 7592, 7632, 7636
Austin,I.G., 6933
Ayant,Y., 7151

Bacchella,G.L., 7512
Bachman,C.H., 6574
Bachmann,H., 6464
Bäckström,G., 7221
Bacon,W.E., 7708
Baehr,H.D., 7385-6
Bailey,D.K., 7681
Baker,E., 7336
Baker,R.M.L., Jr, 6450, 6452
Baker,W.R., 6867
Bakhshiev,N.G., 6713, 6716
Balashov,V., 7639
Baldwin,J.E., 6448
Balkanski,M., 6915
Ball,J.B., 7353
Ballik,E.A., 6709
Balluffi,R.W., 7532, 7534
Banbury,P.C., 6959
Bancie-Grillot,M., 6767
Banerjee,B.R., 7050
Barber,D.R., 7687
Barnes,G.A., 6959
Barrett,L.R., 6580
Barros,F.de S., 7346
Barth,C.A., 6710
Bartleson,C.J., 6813
Bartnitskaya,T.S., 6941
Baruch,P., 7523
Bassali,W.A., 6559-61
Bassani,F., 7500-1
Bassi,P., 6568
Batdorf,R.L., 7533
Bateman,T.B., 7551
Batterman,B.W., 7650
Bauer,H.J., 7428
Baumeister,P.W., 6788
Baumel,P., 7228, 7283
Baus,R.A., 7694
Bayes,K.D., 6708
Bażański,S., 6486
Bazer,J., 7211
Beachell,H.C., 6742
Bearman,R.J., 6597
Beattie,A.R., 6918
Bebchuk,A.S., 6577
Becker,E.W., 6603
Becker,J.J., 7162
Beeman,W.W., 7046
Beer,A.C., 6921
Bég,M.A.B., 7255
Begun,G.M., 7401
Behring,W.E., 6466
Beitel,F.P., Jr, 7169
Bell,J.F., 6627
Bell,M.D., 7486
Bell,R.O., 7178
Belser,R.B., 7001
Beltrametti,E.G., 7367
Ben-Arieh,J., 7279
Bendt,P.J., 6846-7
Benesi,H.A., 6727
Benisz,J., 7244
Bennett,J.M., 6782
Benoit á la Guillaume,C., 6766
Benzler,H., 7372-4
Beran,M.J., 6677
Berger,M.J., 7700
Berko,S., 7503
Berkowitz,J., 6837, 7475
Berlowitsch,E.J., 7231
Bernardes,N., 6528, 7453
Bernardini,M., 7243
Berning,W.W., 7682
Bernstein,H.J., 6748

Bernstein,R.B., 7565-6
Berry,R.S., 7456
Bertaut,E.F., 7643
Berz,F., 6606
Besse,Y., 6816
Beyrich,W., 6603
Bhagiratha Rao,E., 7673
Bhattacharyya,B.K., 7216
Bhawalkar,D.R., 6895
Biber,H.E., 7017
Bieniewski,T.M., 6757
Bier,K., 6603
Bierly,J.N., 6945
Biermann,L., 6458
Bigeleisen,J., 7572
Bijl,D., 7184
Bijvoet,J.M., 7618
Billmeyer,F.W.,Jr, 6775
Bills,D.G., 7715
Bingel,W.A., 7458-9
Binks,J.H., 7417
Birkeland,J.W., 7668
Birks,J.B., 6868, 6876
Birman,J.L., 7498
Birnbaum,G., 7473
Bisi,A., 7326
Bisi,F., 7089
Bisi,V., 7285
Biswas,N.N., 7284
Bitterli,C.V., 6790
Blackman,L.C.F., 6946, 7156
Blaise,P., 6687
Blanc-Lapierre,A., 6540
Bland,J.A., 6834
Bleil,C.E., 6987
Blifford,I.H.,Jr, 7694
Bloch,C., 6503
Bloomer,R.N., 6609
Blottiau,F., 6812
Blum,N.A., 6853
Boag,J.W., 7238
Böer,K.W., 6759
Boerboom,A.J.H., 7096
Bollini,C.G., 7388
Bolz,L.H., 7466
Bond,W.L., 6836
Bonitz,M., 7231
Bonner,T.W., 7366
Borgest,V.A., 6756
Borisov,Yu.Ya., 6577
Borovskii,I.B., 6451
Borsellino,A., 7477
Bortner,T.E., 7115, 7128
Bosco,B., 7280
Bose,S.K., 6524
Böttcher,F., 7080
Bouman,J., 7625
Bouman,M.A., 7701
Bowers,V.A., 7188
Bowlden,H.J., 6935
Boyd,D.R., 7596
Boyd,R.H., 6866
Boyd,R.L.F., 6439
Boyle,W.S., 6964
Brackmann,R.T., 7410
Bradley,R.C., 7527
Bradt,P., 7569
Brammer,W.G., 7046
Bratenahl,A., 6867
Braun,E.A., 6940
Bray,R., 6956
Breazeale,M.A., 6791
Brehm,J.J., 7122
Brewer,G.R., 7069
Bridgman,P.W., 6841
Brill,P.H., 6952
Brillouin,L., 6543, 6552
Brion,H., 7440
Brisbout,F.A., 7131
Brode,H.L., 6638
Brodersen,S., 7433
Broida,H.P., 7484
Brooks,F.D., 7222
Brooks,H., 6883
Broser,I., 6994
Broser-Warminsky,R., 6994
Brovetto,P., 7243
Brown,D.W., 7180
Brown,F.C., 6939
Brown,H., 7716
Brown,H.W., 7484
Brown,J.N., 7683
Brown,L.C., 7427
Brown,L.L., 7401
Brown,M.M., 7542
Brown,R.J.C., 7203
Brown,S.C., 7091
Brunner,G., 7230, 7251
Brunner,J., 7319
Buchdahl,H.A., 6536
Buckingham,A.D., 6871, 7469
Buddemeier,R.W., 7580
Bueche,F., 6587
Bukovics,E., 6557
Bulkin,P.S., 7021
Buras,B., 7494
Burbidge,G.R., 6447
Burghoff,H., 6603
Burleson,G.R., 7358
Burrus,C.A., 6744
Busing,W.R., 7619
Butkovich,T.R., 6835
Button,K.J., 6970
Byron,S.R., 7412

Cabibbo,N., 7277
Caglioti,G., 7223
Cahill,W.F., 6822
Cahn,J.W., 6858
Calhoun,B.A., 7177
Cameron,A.G.W., 6442
Campbell,F.W., 7704
Candlin,D.J., 6514
Cano,R., 6568
Cano Ruiz,J., 7472
Cardona,M., 6883
Carlson,R.O., 6979, 7186
Carman,P.D., 7716
Carr,E.F., 6880
Carr,T.D., 6446
Carrelli,A., 7269, 7578
Carroll,C.W., 6856
Carroll,P.K., 7420
Carstensen,E.L., 6644
Casal.P., 6540
Cashion,J.K., 6773-4
Caticha-Ellis,S., 7644
Ceccarelli,M., 7284
Celli,V., 7501
Cervellati,R., 7223
Cester,R., 7285
Chace,W.G., 6570
Chaleat,R., 6618
Chamberlain,O., 7262
Chambers,Ll.G., 6492
Champion,F.C., 7225
Chandrasekhar,S., 7657
Chandy,K.C., 6895
Charandas,P., 7468
Chen,J.M., 7239, 7291-2
Chester,G.V., 6905
Chew,G.F., 7241
Choquard,P., 6912
Chou,C., 6854
Choudhury,D.C., 7338
Christy,R.W., 7559
Chupka,W.A., 6837
Chyliński,Z., 7244
Chynoweth,A.G., 6892
Claassen,H.H., 7416
Clark,C.D., 6752
Clark,M.,Jr, 6649
Clayton,L., 7467
Clusius,K., 7403-6
Coates,R.J., 6461
Cocanower,R.D., 6565
Cochran,E.L., 7188
Coffin,F.D., 7030
Coggeshall,N.D., 7124
Cohen,M.H., 7399, 7497
Cohn,H.O., 7365
Coldwell-Horsfall,R.A., 6943
Cole,G.H.A., 6591
Cole,H., 7491
Cole,K.D., 7690
Coleman,B.D., 7555
Colley,D.C., 7227
Collin,J., 7117
Collins,L.E., 7090
Collins,R.L., 7486
Connick,R.E., 7198
Cook,D.L., 7172
Cook,G.R., 7126
Cook,J.S., 6881
Cook,M.A., 6576
Corenzwit,E., 7171
Cormack,A.M., 7634
Corso,J.F., 7707
Costa,N.L., 7321
Costain,C.C., 7471
Cowan,R.D., 6847
Cowley,J.M., 7655
Cowling,T.G., 7661
Cozza,G., 7578
Craggs,J.W., 6623
Cramer,W.H., 7408
Cranberg,L., 7101, 7340
Crane,R.C., 6757
Crawford,F.S.,Jr, 7282, 7360
Crawford,H.R., 6583
Cresti,M., 7282
Crick,F.H.C., 7609
Croce,P., 6680
Cromer,A.H., 7339
Cruickshank,D.W.J., 7489
Crussard,J., 7284
Cunningham,R.W., 6956
Curl,R.F.,Jr, 6746
Curran,D.R., 7487
Cybulska,E.W., 7321
Czyzak,S.J., 6757

Dahler,J.S., 6549
Dalgarno,A., 7411
Dall,H.E., 6575
Dalven,R., 7552
Daly,E.F., 6700
Damiano,V.V., 7602
D'Angelo,N., 7263
Daniels,F.B., 6654
Danti,A., 6729
Darby,J.B.,Jr, 7532
Darling,W.R., 6685
Darveniza,M., 6770
Das,T.P., 7450
D'Asaro,L.A., 7527
Dascola,G., 7284
Dash,W.C., 7598
Dattner,A., 7142
Dauvillier,A., 6459
David,H.G., 7575
Davidson,W., 6444
Davies,R.O., 6590
Davis,D.H., 7290
Davis,H., 7713
Davis,R.H., 7366
Davisson,J.W., 7037, 7591
Davydov,A., 7297
Day,R.B., 7257, 7308
De,J., 6469
De,M., 6785
Dean,P., 7493
Deatherage,B.H., 7705, 7713
Debenedetti,A., 7285
Debrunner,P., 7318
Decker,L., 6658
De Dominicis,C., 6503
de Klerk,J., 6628
De Lacoste, 7088
Dell'antonio,G.F., 6511
DeMarco,J.J., 7651
Demarcq,J., 6816
De Maria,G., 7123
Demeur,M., 7298
De Michelis,B., 7089
DeMott,D.W., 7703
Demuynck,A., 6818
Dessy,R.E., 7201
Deutsch,J.P., 7323
Devare,H.G., 7320
DeVore,H.B., 7000
de Witte,A.J., 6678
De Wolff,P.M., 7611, 7640
Dexter,R.N., 6947
deZafra,R.L., 7252
Dharmatti,S.S., 7195
Dibeler,V.H., 7569
Di Bernardo,A., 6755
Diesen,R.W., 7563
Dietzel,K., 6680
Dillon,J.A.,Jr, 7528, 7546
Dingle,H., 6484
Dinsdale,A., 7587
Dixon,J.R., 6973
Doderer,G.C., 6797
Døderlein,J.M., 7389
Dolphin,G.W., 7238
Domb,C., 7492
Donahoe,F.J., 6945
Doran,D.G., 7487
Dorda,G., 6949
Dornberger-Schiff,K., 7594
Douglas,R.W., 6908
Douglass,D.C., 6596
Doumont,G., 7323
Dove,D.B., 7593
Dowden,R.L., 7697
Doyle,M.V., 7535
Drabble,J.R., 6944
Dragoun,Z., 7505
Drahokoupil,J., 6988
Draper,J.E., 7333
Drell,S.D., 7276
Dresner,J., 6771
Drickamer,H.G., 6721
Dricot,G., 7212
Driesner,A.R., 7557-8
Dropkin,D., 6829
Drowart,J., 7123
Droz-Vincent,P., 6490
Druzhinin,A.V., 7084
Dubinina,E.M., 7083
Dudziak,W.F., 7271
Duff,R.E., 6637
Duffieux,P.M., 6556
Duffin,W.J., 7617
Duijvestijn,A.J.W., 7003
Durandeau,P., 7081
Duska,L., 6562
Dye,Y.B., 7273

Eagle,D.F., 6743
Eastwood,W.S., 7310
Ecker,G., 7120-1
Edwards,S.,Jr, 7347
Egan,R.D., 7684
Ehrenreich,H., 6928
Eiland,P.F., 7633
Eisenstadt,M., 7481
Eklund,K., 7086, 7100

kspong,A.G., 7229
ldred,K., 6664
ldredge,D.H., 7713
lias,I., 6648
linson,M.I., 7055
l Khishin,M., 7348
llinger,F.H., 7649
lliott,R.O., 6831
l Nadi,M., 7348
lwyn,A.J., 7364
nge,H.A., 7097
ngelbrecht,J., 6441
nright,D.P., 6973
nz,C.P., 7245
nz,H., 6761
pstein,S.T., 6533
ricson,W.B., 7211
rpenbeck,J.J., 7479-80
shleman,V.R., 7679
tzel,H.W., 6722
vans,D.M., 6917
vans,J.C., 6735
vett,A.A., 6862, 7715
wald,A.W., 6982
wald,P.P., 7610
zawa,H., 7266

abrikant,V.A., 7397
agot,B., 7081
airhall,A.W., 7353
an,H.Y., 6731
ara,H., 7534
arnsworth,H.E., 7528, 7530, 7546
avella,L., 7259
ederighi,T., 7515
einberg,R., 7024
einstein,A., 6542
enton,A.G., 7138
erguson,J., 6764
erroni,S., 7243
ert,C., 7081
ield,G.B., 6714
ielding,P., 6937
ilimonov,V.N., 6732
ilippov,G., 7297
ink,H.J., 7002
ink,R.W., 7317
inkelstein,D., 6509
ischer,G., 6937
isher,D.J., 6698
isher,F., 7059
isher,J.C., 7174
isher,M.E., 7154
ite,W.L., 7410
itzgerald,E.R., 6619
lautt,T.J., 7201
letcher,N.H., 7599-600
letcher,P.C., 7178
lorin,R.E., 7180
ocardi,S., 6568
olberth,O.G., 6936
oner,S.N., 7188
ord,J., 6589
orst,G., 7093
orsyth,P.D., 7346
owler,A.B., 6951
owler,J.L., 7365
owler,P.H., 7699
ox,D., 6984
ozard,J.L., 7708
rancis,E.L., 6479-82
rancis,E.W.R., 6609
rançon,M., 6586, 6799
ranklin,A.D., 6874
ranklin,J.L., 7569
ranklin,J.S., 6676
ranks,A., 7045
ranson,K.D., 7543
ranzosini,P., 7406

Frasco,D.L., 6728
Fraser,R.D.B., 7478
Fred,M., 7441
Freeman,H.C., 7607
Freier,P.S., 7132, 7136
Fricke,F., 7047
Friedlander,G., 7336
Friedrich,J., 6616
Frisken,W.R., 7332
Frost,D.C., 7127
Fubini,S., 7280
Fujii,A., 7267
Fulbright,H.W., 7349
Fulco,J.R., 7261
Fuoss,R.M., 7577
Furlani,C., 7461
Furth,H.P., 6867
Fuschillo,N., 6945

Gabbard,F., 7366
Gaeta,F., 7578
Galifret,Y., 6674
Gallagher,J.S., 7016
Gallet,R.M., 7213
Gallup,G.A., 7418-19
Galzenati,E., 7287
Gamba,A., 6524
Gandon,Y., 6586
Ganesan,S., 6832
Garaycochea,I., 7589
Gardner,G.H.F., 7660
Garelli,C.M., 7285
Garland,C.W., 7552
Garn,W.B., 6860
Garner,W.R., 6661
Garriott,O.K., 7218
Gärtner,W.W., 6953, 6965
Garvin,D., 6711
Garwin,E.L., 7362
Garwin,R.L., 7240
Gáspár,R., 6864
Gatto,R., 7356
Gaume,F., 7149
Gautschi,W., 6436
Gaydon,A.G., 7436
Gazis,D.C., 6641-2
Gehatia,M., 6599
Geissler,D., 6491
Gel'berg,A., 7054
Geluk,J.J., 6653
Gemmell,D.S., 7335
Gerjuoy,E., 7407
Germagnoli,E., 7326, 7512
Gerold,V., 7047
Gerritsen,H.J., 6983, 6989
Geshkenbein,B.V., 7328
Gessaroli,R., 7284
Giacomo,P., 6788
Gibbins,S.G., 7464
Gibbons,J.J., 7676
Gibson,A.F., 6960
Giese,C.F., 6837, 7092
Gill,D., 7573
Gillespie,T., 6584
Gilvarry,J.J., 6493
Giron,V.S., 7170
Glashow,S.L., 6518
Glasoe,G.N., 7364
Glazov,A.A., 7029
Gleissberg,W., 6454
Glicksman,M., 6974
Glinchuk,K.D., 6954
Globe,S., 6829
Glorig,A., 7711-12
Gobeli,G.W., 7525
Goel,P.S., 7695
Göing,M., 7284
Gold,L., 7070, 7570
Gold,T., 7691
Goldberger,M.L., 6531

Goldemberg,J., 7321
Goldhaber,G., 7262
Goldsmid,H.J., 7014
Goldstein,M., 6794-5
Goldstein,S., 6953
Goldstone,G.T., 7697
Gomer,R., 7056
Good,M.L., 7282
Goodings,D.A., 7399
Goodman,G.L., 7441
Goodman,L., 7457
Goodyear,J., 7617
Gopalaswamy,T.R., 6906
Gordon,J.E., 6734
Gordy,W., 7185
Gossick,B., 6990
Gottstein,K., 7282, 7284
Gould,C.L., 6607
Gouterman,M., 6723
Govaerts,J., 7237
Graham,C.D., Jr, 7157-8
Graham,E.H., 7702
Granata,S., 7512
Gränicher,H., 6898
Grant,D.F., 7638
Greaves,J.C., 6711
Green,D.M., 7710
Green,M., 6926
Greenblatt,M.H., 7076
Gregory,A.R., 7660
Griffel,M., 7153
Griffing,V., 7460
Grillot,E., 6767
Grimes,L.G., 6845
Grimminger,G., 7665
Grinberg,A.P., 7307
Grisaru,M.T., 6667
Grögler,N., 6772
Gronvøld,F., 6854
Gross,F.L., 6784
Grosset,G., 6691
Grosskreutz,J.C., 7048
Grumet,A., 7204
Gubanov,A.I., 6670
Guében,G., 7237
Guentner,W.S., 7581
Guggenheimer,K.M., 7268
Guinier,A., 7612
Gulmanelli,P., 6511
Gunn,J.B., 6962
Guptill,E.W., 6833
Gurney,T.R., 7556
Gush,H.P., 6725
Gutbier,H., 7129
Gutowsky,H.S., 7454
Guyon,E., 7612

Hage,W., 7381
Hagstrom,S., 7445
Haine,M.E., 6609
Halbert,M.L., 7355
Halbwachs,F., 6498
Hall,D.N., 6645
Hall,R.N., 6979
Halperin,A., 7517
Halpern,I., 7353
Halsey,G.D., Jr, 6842
Halter,J., 7319
Hamann,S.D., 7575
Hamano,H., 7451
Hambleton,G.E., 6965
Hamilton,W.C., 7163, 7605
Hamming,R.W., 7194
Handler,P., 6958
Hanke,L., 6520
Hansen,W.N., 7153
Hardwick,T.J., 7581
Hardy,H.C., 6666
Hare,W.F.J., 6725
Harkness,A.L., 7352

Harnik,E., 6955
Harrell,R.W., 7457
Harrick,N.J., 6800-1, 6924
Harris,E., 7583
Harris,G., 7228, 7283
Harrison,E.R., 7078
Hart,E.W., 6859
Hart,R.W., 6844
Hartman,P., 7601
Hartman,P.L., 6997
Hashimoto,H., 7545
Hashman,J.S., 7568
Haskin,L.A., 7558
Haslett,J.C., 6977
Hass,G., 6778
Haszko,S.E., 7176
Hatch,E.N., 7342
Hauptman,H., 7621-4
Havliček,F.I., 7311
Hawkins,G.S., 6449
Hayakawa,S., 6763
Haynes,S.K., 7325
Hearmon,R.F.S., 7548
Heastie,R., 6600
Heavens,O.S., 7542
Hebel,L.C., 7006
Heer,E., 7318
Heine,V., 7399, 7497
Heisler,L.H., 6474, 7672
Heller,W., 6798
Helliwell,R.A., 7698
Henderson,D.J., 7351
Hennessy,J., 7284
Henshall,J.B., 7101
Hensler,J.R., 7519
Hensley,E.B., 6753
Herman,M., 7602
Herring,C., 6913
Herrmann,O., 6610
Herron,J.T., 7569
Hersh,H.N., 7516
Hibdon,C.T., 7301
Hicklin,W.H., 7001
Hiedemann,E.A., 6791
Higgs,P.W., 6497
Hildenbrand,D.L., 6861
Hill,R.J., 7544
Hill,T.L., 6550, 6593-4
Hindmarsh,W.R., 6706-7
Hinds,S., 7303-5
Hines,C.O., 7678
Hinkelmann,H., 7576
Hinton,V., 7542
Hirashima,Y., 7143
Hirata,M., 6763
Hirsch,P.B., 7603
Hirsh,I.J., 7705
Hisatsune,I.C., 7426
Ho,T.H., 7239, 7273, 7291-2
Hofstadter,R., 7258, 7358
Holloway,J.T., 7330
Holm,C.H., 7199
Holmes,D.K., 7550
Holmgren,H.D., 7350
Honjo,G., 7653
Hopkins,J.I., 7049, 7325
Horai,K., 7181
Hörl,E.M., 7484
Horne,R.A., 7013
Hornig,A.W., 7187
Hoskins,R.H., 7179
Hostettler,H.U., 7404-5
Hottenrott,H.G., 6574
Houston,J.M., 7074
Howard,R., 6460
Howell,K., 7452
Howells,R.G., 7638
Howling,D.H., 6647
Hrehuss,G., 7236
Hubbard,H.W., 7564

Huber,M., 7403
Huber,P., 7116
Hudis,J., 7336-7
Hughes,C.J., 7219
Hughes,E.W., 7626
Hughes,R.E., 7483
Huizenga,J.R., 7351-2
Hukuda,K., 7181
Hultberg,S., 7329
Hunt,K.H., 6558
Hunter,L.P., 7613
Hunzinger,J.J., 6789
Huq,M., 7224
Hurd,J.D., 6891
Hurlbut,F.C., 6612
Hurst,G.S., 7115, 7128
Hurst,R.P., 7606
Hürzeler,H., 7403-4
Husimi,K., 6893
Hutchinson,G.W., 7224

Ibers,J.A., 7199, 7490
Iguchi,K., 6762
Ikeda,T., 6595
Ikegami,H., 7234, 7324
Ikenberry,E., 6478
Il'in,N.P., 6451
Infeld,L., 6487
Inghram,M.G., 7123
Inönü,E., 7392
Inoué,S., 6806
Iosifesku,B., 7054
Iredale,T., 7203
Isaac,P.J., 6613
Isard,J.O., 6907
Ishikawa,Y., 7173
Itsikovich,A., 6675
Ittner,W.B., 7007

Jaccard,C., 6877
Jacchia,L.G., 6472
Jackson,J.E., 6811
Jackson,L.C., 6845
Jacobs,P.W.M., 7544
Jacobson,M.J., 6668
Jaffe,A.A., 7346
Jaffé,H.H., 7201
Jäger,F.W., 6453
Jain,A.L., 6827
James,R.A., 7344
Janner,A., 6912
Jarmie,N., 7341
Jaswon,M.A., 7593
Jatar,D.P., 7027-8
Jauch,J.M., 6526-7
Jauneau,L., 7262
Jayadevappa,E.S., 7426
Jefimenko,O., 6470
Jellinek,F., 7646, 7652
Jen,C.K., 7188
Jenkins,F.A., 6788
Jenns,C.C., 7014
Jha,S., 7320
Joel,N., 7589
Joffe,A., 6929
Joglekar,G.D., 6906
Johansson,S.A.E., 7696
John,K., 6817
Johnson,F.S., 6465
Johnson,H.R., 7394
Johnson,M.H., 7564
Johnson,N.R., 7315
Johnson,P.D., 6751
Johnston,R.L., 7350
Johnston,W.H., 7314
Jones,H.C., 6698
Jones,R.E., 7007
Jones,W.H., Jr, 6742, 7424
Jones,W.M., 6613
Jortner,J., 6588

Kaczér,J., 7144, 7160
Kahn,F.D., 6669
Kainer,H., 7184
Kaiser,W., 7597
Kalitzin,N.S., 6494, 6564
Kallmann,H., 6771, 6992, 6995
Kalogeropoulos,T., 7262
Kanai,Y., 6825
Kapitsa,M.L., 7062
Kaplan,J., 6710
Kapuy,E., 7442-3
Karle,J., 7621-4
Karplus,M., 7450
Karplus,R., 6538
Kashy,E., 7539
Kästner,S., 6539
Kataoka,K., 6893
Katchalski,E., 6599
Katz,S., 7487
Kaufman,V., 6781
Kawaguchi,M., 7267
Kawamura,H., 6993
Kawano,M., 7693
Kay,H.F., 7583
Kazarinoff,N.D., 7215
Kazarov,R.E., 7135
Keast,D.N., 6567
Keller,J.B., 6578, 7476
Keller,R., 7103
Keller,S.P., 6765
Kelley,M.T., 6698
Kellogg,P.J., 7686
Kelly,J.C., 6787
Kelly,P., 7312
Kelsall,D., 6696
Kempter,C.P., 6831
Kerr,E.C., 6846
Ketelaar,J.A.A., 6730
Kettel,F., 6824
Keyston,J.R.G., 6833
Khizhnyak,N.A., 6886-8
Khokhlov,M.Z., 7021
Kikuchi,R., 7150
Kilpatrick,J.E., 7422
King,J.C., 7549
King-Hele,D.G., 6473, 6475
Kingery,W.D., 7537-8
Kingston,A.E., 7411
Kinoshita,T., 7278
Kinson,J.B., 7227
Kirchenmayer,A., 7378
Kirillova,G.K., 6889
Kiser,R.W., 7314
Kisliuk,P., 7067
Kislovskii,L.D., 6780
Kisslinger,L.S., 7299
Kistiakowsky,G.B., 6708
Kitamura,M.Y., 7118
Kitamura,N., 7653
Kjeldaas,T., Jr, 7496
Klaboe,P., 6741
Klein,A.G., 7232
Klein,F.S., 7572
Klein,L., 6715
Kléman,M., 6499
Klemens,P.G., 6931
Klemperer,W., 7425
Kloepper,R.M., 7308
Klontz,E.E., 7525
Klug,A., 7609, 7645
Kneser,H.O., 7428
Knoepfel,H., 6760
Knopoff,L., 6621-2, 7147
Kobayashi,K., 6939
Kobayashi,S., 7023
Kockum,J., 7235
Kodama,M., 7139
Koehler,W.F., 6782
Koester,C.J., 6803, 6806-7

Köhler,H.J., 6476
Kołos,W., 7447
Kolossvary,B.G., 6563
Koltay-Gyarmati,B., 6864
Komsha,G., 7054
Koomen,M.J., 6468
Kopelman,R., 6733
Korchovei,A., 7175
Korobeinikov,V.P., 7108
Kotaka,T., 7485
Koutecký,J., 7462
Kovács,I., 6717
Koval'skii,N.G., 7015
Kovarskii,V.A., 7520
Kramer,B., 6995
Kramer,W.R., 6861
Kranzer,H.C., 6578
Krassovsky,V.I., 7669
Kraus,G., 7486
Kraus,O., 6942
Krishnamurty,C., 7585
Krogdahl,W.S., 6501
Krumhansl,J.A., 6930
Kruse,P.W., 6991
Kühl,B., 7058
Kul'varskaya,B.S., 7061
Kündig,W., 7318
Kunkel,W.B., 6867
Kurochkin,S.S., 7193
Kuss,E., 6572

Labs,D., 6467
Lacomme,P., 6679
Lad,R.A., 7560
Laegreid,N., 7540
Lagerqvist,A., 6719
Laity,R.W., 6547
Lamb,J., 6590, 6645
Lampert,M.A., 6985, 6998, 7514
Lamport,H., 6646
Land,T., 6851
Landis,C., 7702
Landon,H.H., 7364
Landsberg,P.T., 6918
Lang,A.R., 7614
Langmuir,R.V., 7095
Langseth,A., 7433
Laponsky,A.B., 7068
Lardinois,J., 7298
Lark-Horovitz,K., 6981
Larrabee,R.D., 6671
Lashkarev,V.E., 6954
Laslett,L.J., 7330
Lassen,N.O., 7349
Lassettre,E.N., 7130
Lauer,J.L., 6742, 7424, 7483
Laurie,V.W., 6745
Law,J.T., 7586
Lawson,A.W., 6827
Lax,B., 6970-1
Learner,R.C.M., 7436
LeBlanc,O.H., Jr., 7035
Lederman,L.M., 7240
Ledinegg,M., 7387
Ledoux,P., 7212
Lee,J., 7228, 7283
Lee,T.D., 6537
Lee,T.H., 7033
Leebeek,H.J., 7701
Lehane,J.A., 7134
Lehiste,I., 6657, 6659
Lehmann,L., 7584
Lehmann,W.J., 6736-9
Leinbach,H., 7685
Leipnik,R., 6544
Lemberg,I.Kh., 7307
Lenard,A., 6541
Lenoble,J., 7689
Leo,W., 6704
Leon,M., 7295

Levengood,W.C., 7531
Levey,H.C., 6639
Levi,F.P., 7168
Levy,H.A., 7619
Levy,S., 7017
Levy de Bollini,S.P., 7388
Lewis,T.J., 7034
Liao,T.W., 6873
Lien,W.H., 6855
Lind,D.A., 7308
Lindberg,P.J., 6786
Linder,B., 7344
Lindsay,E.W., 7019
Linfoot,E.H., 6684
Linnett,J.W., 7470
Lipkin,H.J., 6555
Lippert,W., 7085
Lipson,H., 7629
Little,C.G., 7685
Littlejohn,C.S., 7302
Liu,V.C., 6614
Livingston,R., 7189
Livingston,R.L., 7465
Locke,G., 7376, 7382
Lockett,F.J., 6624
Lockhart,L.B., Jr, 7694
Loepfe,E., 6760
Logan,R.A., 6836
Logunov,A.A., 7248-9
Lohmann,A., 6681, 6702
Lokan,K.H., 7345
Long,D., 6978
Longo,T.A., 6981
Lord,R.C., 6729
Loria,A., 7226
Lossing,F.P., 7117
Louck,J.D., 7434
Love,W.F., 6977
Lovell,L.C., 7507, 7509
Low,F.E., 7241
Löwdin,P.O., 7396
Lowell,R., 6827
Luchner.K., 7066
Lüders,G., 7306
Ludwig,G.W., 7186
Lukosz,W., 6682
Lüst,R., 6458
Lutzky,M., 7205
Luz,Z., 7573
Lyman,E.M., 7282

McAllister,H., 6466
McCall,D.W., 6596, 7194
McClintock,F.A., 7547
McClure,F.T., 6844
McConnell,H.M., 7421
McCracken,K.G., 7138
McCusker,C.B.A., 7131
MacDonald,D.K.C., 7011
Macdonald,J.R., 6903
McDonald,R.A., 6861
McDowell,C.A., 7127
MacEwan,D.M.C., 7472
McGarvey,B.R., 7202
MacGregor,M.H., 7260
Machlup,S., 6968
McIntyre,D., 6797
Mackay,J.W., 7525
McKey,M.J., 7710
McLaughlin,E., 6592
MacLean,W.R., 6665
McMillan,J.A., 7145
McNally,J.R., Jr, 6697
McNeill,J.J., 6699
McNutt,J.E., 6585
Macpherson,J.D., 6833
Macq,P.C., 7323
McSkimin,H.J., 6630, 7551
Madansky,L., 7347
Maeda,K.I., 7680

Maglieri,D.J., 6663
Magono,C., 6865
Mahaffey,D.W., 7110
Mahan,A.I., 6790
Maier,A., 7316
Mařecki,J., 7148
Málek,Z., 7144
Malitson,H.H., 6465
Malkovská,M., 6988
Malmon,A.G., 7040
Malurkar,S.L., 7133
Mangelsdorf,P.C.,Jr, 7579
Manning,L.A., 7679
Mansfield,W.W., 6839-40
Maradudin,A.A., 7492
Marchenko,V.B., 7061
Marchukova,I.D., 6451
Maréchal,A., 6680, 6796
Margem,N., 7285
Margenau,H., 6715
Margoninski,Y., 6955
Marić,Z., 7361
Mark,P., 6995
Markov,M., 6502
Marple,D.T.F., 6751
Marquez,L., 7321
Marseguerra,M., 7264
Martienssen,W., 6750
Martyn,D.F., 7674
Marx,G., 6508
Maryott,A.A., 7473
Mason,E.A., 7415
Mason,J.H., 7036
Mason,P., 6625
Masui,T., 6705
Mataré,H.F., 6925
Mathews,J.F., 6946
Mathieson,A.McL., 7615
Matsen,F.A., 7606
Matsunaga,Y., 7449
Matsuo,S., 7369-70
Mauer,F.A., 7466
May,K.R., 7692
Mayer,J.E., 6545
Mayer,M.E., 6505
Mazo,R.M., 6545
Meakins,R.J., 6881
Meckel,B., 7540
Meckel,B.B., 7506
Medcof,M.A., 6667
Medvedev,B.A., 7368
Meiboom,S., 7573
Meisenheimer,R.G., 7172
Meissner;H., 7005
Meissner,K.W., 6781
Melmed,A.J., 7056
Mel'nikov,A.I., 7062
Melton,C.E., 7125
Meltzer,B., 7077
Menarry,A., 7629
Merson,R.H., 6475
Mette,H., 6953
Metz,F.I., 7560
Meyer,K.P., 7316
Meyerand,R.G.,Jr, 7091
Mezger,P., 6445
Mezzetti,L., 7223
Michelini,A., 6568
Michels,A., 6968
Middleton,R., 7303-5
Miduno,Z., 7181
Miescher,E., 6719
Mikhailov,G.S., 7064
Millar,D.D., 7134
Miller,J., 7606
Miller,J.M., 7337
Millington,R.J., 6579
Mills,R.L., 7257
Minkoff,G.J., 7016
Miselyuk,E.G., 6954
Misner,C.W., 6509
Missman,R., 6958
Mitchell,C.M., 7637
Mitchell,J.W., 6940
Mitra,A.N., 6515
Mittner,P., 7226
Miyagawa,I., 7185
Möbius,P., 7361
Moffitt,W., 6805
Molmud,P., 7109
Montroll,E.W., 7492
Moodie,A.F., 7655
Moore,D.G., 7561
Mooser,E., 6937
Mora,S., 7284
Morais,C., 6688
Morgan,M.G., 6456, 7698
Morgan,T.N., 6963
Morita,A., 7499
Morita,M., 7327
Morley,K.A., 7648
Morozov,A.V., 7062
Morozov,V.P., 7437
Morris,D.P., 7152
Morris,D.W., 7219
Morton,A H., 7104, 7335
Moscowitz,A., 6805
Moser,C., 7440
Moses,H.E., 7206
Moss,M., 6823
Moss,T.S., 6975, 7009
Motchenbacher,C.D., 6978
Muelhause,C.O., 7390
Mueller,R.K., 6923, 7513
Mullett,L.B., 6582
Mullins,W.W., 6582
Munro,G.H., 6474
Muralidhara Rao,V., 6882
Murray,A.M., 7155
Musgrave,M.J.P., 7588
Mussa,G., 7054
Myers,J., 6978

Nachbar,W., 6617
Nadol'skii,V., 6675
Nagai,K., 7482
Nagakura,S., 7654
Nagy,K.L., 6507
Naish,J.M., 6695
Nakagaki,M., 6798
Nakagawa,K., 7281, 7289
Nakamura,M., 6440, 7012
Nakatani,S., 7693
Nakayama,T., 7118
Nakhodkin,N.G., 7063
Namioka,T., 6792-3
Narasappaya,N., 7695
Narasimha Rao,D.V.G.L., 6897
Narasimhan,M.D., 7538
Narayana Rao,M., 7320
Narayanaswamy,P., 6515
Narumi,H., 7369-70
Naseem,M., 6571
Nassif,M., 6559
Nathan,O., 7329
Nathans,R., 7173
Naya,S., 7627
Neaga,V.G., 6605
Nejak,R.P., 7581
Nemilov,Yu., 7065
Neporent,B.S., 6713
Nesbitt,E.A., 7171
Neszmélyi,A., 7236
Nettleton,R.E., 6640
Nettley,P.T., 7590
Neuringer,L.J., 6754
Newton,R.R., 6471
Ney,E.P., 7132, 7136, 7141, 7686
Neynaber,R.H., 7046
Nickel,J.C., 7554
Nicolet,M., 7666-7
Nielsen,C.E., 7099
Nielsen,J.R., 6741
Nii,R., 6825
Nikitine,S., 6718
Nishjima,K., 6504
Nolle,A.W., 7553
Nölle,E., 7018
Norman,N., 7051, 7635
Northwood,T.D., 6667
Nosanow,L.H., 6551
Nottingham,W.B., 7072
Novikov,D.L., 7029
Nysäter,H.M., 7146

Oberländer,S., 6759
O'Connor,D., 7494
Ogawa,M., 7126
Ogier,W.T., 7554
O'Kelley,G.D., 7315
Okura,H., 6993
Oleksa,S., 7364
Oliveiria,C.G., 7275
Olivetti,M., 7259
Ollendorff,F., 7057, 7207
Onak,T.P., 6736-7
Onaka,R., 6440
Ōno,M., 7167
Onu,V., 6850
Ooba,N., 6673
Orear,J., 7228, 7283
Otte,H.M., 7603
Otterman,J., 6634
Overmeyer,J., 7177
Owen,A.E., 6908
Owen,G.E., 7347

Padgett,A.A., 7460
Pais,A., 6530
Pal'chikov,V.E., 7015
Palko,A.A., 7400
Pande,L.K., 6515
Panseri,C., 7515
Papapetrou,A., 6491
Paranjape,B.V., 6916
Park,D., 6488
Parker,E.N., 7107
Parker,P.M., 7427
Parrish,W., 7611
Paskin,A., 7608
Paslay,P.R., 6620
Pastor,R.C., 7179
Păstrăvanu,M., 6850
Patterson,D.A., 6722
Paul,W., 6883
Pauli,G., 7264
Pauthenet,R., 7170
Pawlikowski,A., 6554
Payne,H., 7395
Payne,W.T., 6489
Pearson,R,G., 7431
Pedos,F.Z., 6701
Peerdeman,A.F., 7618
Peiser,H.S., 7466
Pell,E.M., 6979
Penner,S.S., 6617
Pepinsky,R., 7633
Peres,A., 6495-6
Perkins,W.H., 6446
Perry,J.E.,Jr., 7257
Perry,R.R., 7539
Peshkov,V.P., 6849
Peters,C.W., 6724
Peterson,A.M., 7684
Peterson,G.E., 6657, 6659
Petritz,R.L., 6957
Peyron,M., 7484
Phillips,J.C., 6966
Phillips,K., 7020
Phillips,N.E., 6855
Phillips,N.J., 6615
Phillips,R.J.N., 6532
Phillips,W.E., 7325
Picasso,L.E., 7294
Pickart,S.J., 7173
Piddington,J.H., 7111
Piekara,A., 7148
Piercy,B., 6884
Piéron,H., 6674
Piette,L.H., 7200, 7439
Pike,E.R., 7616
Piper,W.W., 6751
Pirani,F.A.E., 6485
Pistorius,C.W.F.T., 7414, 7423, 7432
Plaskett,J.S., 7503
Plump,R.E., 6873
Plumpton,C., 7210
Pócsik,G., 6512
Podgornȳi,I.M., 7015
Pohl,H.A., 6900
Polanyi,J.C., 6773-4
Pollack,I., 6658
Pope,M., 6992
Popov,B.N., 7062, 7084
Popper,P., 6875
Portis,A.M., 6934
Post,D., 6804
Potts,W.J., 7430
Poulsen,N.O.R., 7349
Poulson,R.E., 7198
Powell,R.E., 7567
Powers,R.W., 7535
Powles,J.G., 7192
Prabhakara,C., 7695
Prakash,P., 7274
Pratt,D.S., 7684
Pratt,G.W.,Jr., 6927
Prendergast,K.H., 7208
Prener,J.S., 6920
Price,C.E., 7663
Price,P.J., 6910
Primak,W., 6804, 7524
Primakoff,H., 7453
Privalova,V., 7065
Proctor,T.M., 6904
Prod'homme,L., 6815
Prout,E.G., 7582
Pryamkova,I.A., 7083
Pryor,A.W., 7232
Pugh,E.M., 7169
Purbrick,R.L., 6712
Purcell,J.D., 6465
Püschel,W., 7284
Putman,J.L., 7310
Pütter,P.S., 7379

Quareni,G., 7284
Quassiati,B., 7285
Quirk,J.P., 6579
Qurashi,M.M., 6571

Raab,R.E., 6871
Rabinovich,I.B., 7463
Rabinovitch,B.S., 7563
Radicati,L.A., 7367
Radoslovich,E.W., 7647
Rama Thor, 7695
Ramachandra Rao,B., 6631, 7585,7673
Ramakrishnan,A., 7270
Ramana Murty,Y.V., 7673
Ramdas,A.K., 6731
Ramler,W.J., 7351-2
Ramsay,D.A., 6709
Ranganathan,N.R., 7270
Rao,C.N.R., 7465
Rao,V.S., 7481
Rasmussen,J.O., 7322
Rastogi,R.G., 7671

Rathgeber,H.D., 7140
Rathgeber,M.H., 7134
Ray,R.K., 6981
Rayski,J., 6506, 6521
Redwood,M., 6632
Reeber,M.D., 7004
Refsum,A., 7020
Reiling,G.H., 6753
Reiss,H., 7536
Reitan,A., 7435
Remeika,J.P., 7161
Remillard,W.J., 6652
Rempel,R.C., 7187
Rense,W.A., 6466
Resnick,P., 6755
Reuben,B.G., 7470
Reynolds,G.F., 7201
Reynolds,S.I., 7038
Reynolds,W.L., 6598
Řezanka,I., 7079
Rice,S.A., 6546
Riddiford,L., 7227
Riesch,G., 7380
Rimsky,A., 7644
Rinehart,J.S., 6565
Risser,J.R., 7539
Ritow,H., 7032
Ritt,R.K., 7215
Rittner,E.S., 6863
Riviere,A.C., 7090
Roach,F.E., 7688
Roberts,S., 6779
Robertson,W.W., 7429
Robin,L., 6435
Robin,S., 6703
Robin,St., 6703
Robinson,B.L., 7317
Robinson,N.W., 6606
Robinson,W.H., 7042
Robson,A.E., 7026
Rodot,M., 6976
Rogers,D., 7638
Rohrlich,F., 7394
Rollins,F.R., 7048
Ronne,B.E., 7229
Rosati,S., 7294
Rösch,S., 6802
Rose,A., 6983, 6985, 6989, 6998, 7514
Rose,D.C., 7138
Rose,F.W.G., 6919
Rose,H.J., 7342
Rose-Innes,A.C., 7184
Rosenbruch,K.J., 6694
Rosenhauer,K., 6694
Rossel,J., 6761, 7363
Rotblat,J., 7238
Roth,J., 6857
Roth,L.M , 6927, 6970-1
Rothberg,G.M., 7481
Roy,J.C., 7313
Roy,L.P., 7313
Rozenberg,L.D., 6577
Rozhdestvenskii,V.V., 7307
Rozkoš,M., 7359
Rozman,I.M., 6769
Rubbia,C., 6568
Rubenstein,H., 6658
Rudolph,P.S., 7125
Ruehrwein,R.A., 7568
Ruelle,D., 6510
Rüetschi,R., 7318
Ruffler,H., 6758
Runcorn,S.K., 7662
Ruppel,W., 6983, 6989
Ruske,W., 7164
Russell,M.E., 7565-6
Rustgi,O.P., 6777
Ryhage,R., 7098

Saavedra,I., 6516
Sachs,M., 6513
Sagane,R., 7271
Sakadi,Z., 6573
Sakai,M., 7234, 7324
Sakamoto,Y., 7488
Sakurai,J.J., 6519
Sala,O., 6747
Salmon,J., 7088
Sampson,D.H., 6843
Samson,J.A.R., 7126
Samuels,J.C., 6626
Sanders,T.M.,Jr, 6969
Saporetti,F., 6568
Sato,H., 7150
Sato,S., 6821
Sato,T., 7680
Sauer,J.A., 7474
Saunders,H., 6620
Saunders,J.B., 6784
Savino,J.M., 6604
Sawicki,J., 7256
Sbitnikova,I.S., 7083
Scari,O., 6717
Schade,W.J., 6710
Scharf,B., 6660
Schatzki,T.F., 6602
Scheibe,K., 6569
Scherb,F., 7257
Scherber,F.I., 7016
Scherer,J.R., 7430
Scherrer,P., 7319
Şchiopu,M., 6850
Schirmer,H., 7105-6
Schleede,A., 6768
Schlesinger,M., 7517
Schlier,R.E., 7528, 7530, 7546
Schlumbohm,H., 7233
Schlüter,A., 7113
Schmidt,H., 6441
Schmidt,P.W., 7041
Schneider,T., 6672
Schnepp,O., 6733
Schonland,D.S., 7182
Schossberger,F., 7543
Schranz,P., 6672
Schubert,K., 7620
Schulman,J.H., 6868
Schumacher,E., 7403-4
Schwan,H.P., 6644
Schwar,J.P., 6900
Schwarz,R.F., 6952
Schwerdt,K.R., 7547
Scofield,J.H., 7250
Scotoni,I., 7226
Scott,A.B., 7518
Scott,S.A., 7331
Seeger,A.K., 7511
Segall,B., 6967
Segrè,E., 7262
Sen,D.C., 7239, 7273, 7291-2
Serber,R., 6530
Seriff,A.J., 7659
Sessler,A.M., 7099
Shaffer,W.H., 7434
Shakeshaft,J.R., 6448
Shapiro,I., 6736-9, 7464
Shapley,A.H., 7658
Sharf,D.J., 6656
Sharma,H.D., 7028
Sharp,R.T., 6525
Shaukat,M.A., 7290
Shaw,J.H., 7668
Shelton,H., 7095
Sherwood,R.C., 7161
Shipley,E.F., 7710
Shirane,G., 7173
Shook,G.B., 7354
Shpigel',I.S., 6611

Shuleshko,P., 6437-8
Shull,H., 7396, 7445, 7452
Shul'man,A.R., 7062
Shulman,R.G., 7197
Sibbitt,W.L., 6604
Sihvonen,Y.T., 7596
Silberberg,R., 7262
Sim,G.A., 7631
Simmons,B.E., 7393
Simon,R., 7209
Simonyi,K., 7236
Simpson,A.W., 6891
Singh,H., 7553
Singh,J., 7664
Singh,V., 6529
Singru,R.M., 7320
Sirlin,A., 7278
Sittig,E., 7428
Sittkus,A., 7584
Skertchly,A.R.B., 7604
Sklar,D.L., 7711-12
Sklyarevskii,V.V., 7368
Sladek,R.J., 6911
Slater,N.B., 7413
Slater,P.N., 6566
Slichter,C.P., 7006, 7495
Slichter,L.B., 7147
Slomp,G.,Jr, 7202
Small,A.M.,Jr, 7708
Smallman,R.E., 7044, 7510
Smith,A.G., 6446
Smith,E.B., 6548
Smith,J.E.W.L., 7607
Smith,R.W., 6999, 7514
Smith,S.D., 6975
Smith,W.I.B., 7104, 7335
Smith,W.V., 7177
Smitz,F.M., 7533
Smoluchowski,R., 7042, 7508, 7526
Snow,W.R., 7410
Snyder,D.D., 6987
Sobolevskaya,R.B., 7062
Soffer,L., 6914
Sokolov,N.D., 7196
Solmitz,F.T., 7282
Solntsev,G.S., 7022
Solomon,L.N., 7706
Solovyov,L.D., 7248
Sommer,A.H., 6938
Sommer,J., 7562
Sommerfield,C.M., 6538
Spence,R.D., 6534
Spencer,H.E., 6996
Spencer,L.V., 7700
Spicer,W.E., 6938
Spiewak,M., 6986
Spitzer,W.G., 6948
Spivak,G.V., 7083
Spokas,J.J., 7495
Sponer,H., 7446
Sproull,R.L., 6823
Srinivasan,S.K., 7270
Srirama Rao,M., 7670
Srivastava,B.N., 6601, 6828
Srivastava,K.P., 6601
Srivastava,R.C., 6828
Stahl,H.A., 6820
Stammreich,H., 6747
Stanghellini,A., 7280
Stannard,F.R., 7290
Starfelt,N., 7235
Stauffer,H., 6772
Stauss,H.E., 7166
Stedman,C.K., 6650
Steele,M.C., 6974
Stehle,P.M., 7255
Steinemann,A., 6898-9
Steinhaus,D.W., 6809
Stepanov,E.P., 7368

Stepanov,G.V., 7061
Stephens,D.R., 6721
Stephens,R.E., 6686
Sternberg,J., 6636
Stevenson,M.L., 7282, 7360
Stevenson,R.W.H., 7590
Stewart,J.E., 6740
Stoeckly,R.E., 7547
Stoicheff,B.P., 7471
Stoll,P., 6760
Stolz,H., 7008
Strachan,C., 7155
Strauss,A.J., 6972
Stribel,T., 7334
Stubbe,L., 6990
Stull,D.R., 6861
Subba Rao,K., 6631
Subramanian,N.R., 6906
Sudarshan,E.C.G., 6524
Suk,M., 7272
Sullivan,J.H., 7571, 7574
Sundara Rao,K.J., 7195
Sutton,P.M., 6904
Suzuki,T., 6690
Sventitskii,N.S., 6701
Sverdlin,A.S., 7438
Swalin,R.A., 7506
Swami,M.S., 7293
Swanekamp,F.W., 7176
Swets,J.A., 7709-10
Sykes,M.F., 7154
Szczurówna,W., 6554
Szulkin,P., 7217
Szwarc,M., 7417

Taguchi,I., 7627
Takagi,M., 7656
Takahashi,H., 7391
Takahashi,T., 6865
Takahasi,U., 7488
Tamássy-Lentei,I., 6864
Tamura,T., 7338
Tannenwald,L.M., 7087
Tarbet,C.S.C., 6700
Tasman,H.A., 7096
Tauber,G.E., 6914
Tauc,J., 6922, 6988
Tavares,Y., 6747
Taylor,C.A., 7648
Taylor,H.E., 6896
Taylor,H.W., 7331-2
Taylor,I.J., 7346
Taylor,J.M., 7611
Taylor,J.W., 6997
Taylor,K.W., 6975
Taylor,S., 7228, 7283
Ten Seldam,C.A., 6968
ter Haar,D., 6943
Terhune,R.W., 6724
Theimer,O., 7119
Thellung,A., 6905
Théodoridès,P., 6633
Thielheim,K.O., 7377
Thirring,W., 6517
Thomas,A.G., 6580
Thomas,D.G., 6749
Thomas,J., 7151
Thomas,J.B., 6662
Thomas,J.O., 7677
Thomas,K., 7045
Thomas,K.A., 6707
Thomas,R.N., 6457
Thompson,D.O., 7550
Thonemann,P.C., 7026
Thornton,B.S., 6783
Thornton,H.R., 7561
Thorp,J.M., 6885
Thurmond,C.D., 7597
Ticho,H., 7282
Tietge,J., 7284

ietz,T., 7398
iomno,J., 7275
oll,J.S., 7205
olpȳgo,K.B., 7060
omizuka,C.T., 7532
onndorf,J., 7714
ortrat,A., 6540
oupin,R.A., 6902
ousey,R., 6465, 6778
oye,T.C., 7053
oyozawa,T., 7504
reder,H., 6491
redgold,R.H., 6891
reiman,S.B., 6531
rent,H.M., 6483
riebwasser,S., 6890
rigger,K.R., 7179
rost,A., 7039
sarev,B.M., 7062
sidil'kovskii,I.M., 6941
subouchi,T., 6821
sujiuchi,J., 6692
uan,S.F., 7286
ufte,O.N., 6982
urrell,G.C., 6734
utovan,V., 7159
uttle,T.R., Jr, 7183
zu,H.Y., 7239,7273, 7291-2

bbelohde,A.R., 6946
mezawa,H., 7289
pton,E.K.L., 6449
rban,P., 6520
rsell,H.D., 7639
sui,T., 6848
woki,I., 6690

alkó,I.P., 7059
and,V., 7633
n der Elsken,J., 6730
anderryn,J., 6726
anderslice,J.T., 7415
n der Spuy,E., 7247
an Duzer,T., 7069
an Eck,J., 6968
anhuyse,V.J., 7102
an Uitert,L.G., 7176
an Winkle,M., 6583
asek,L.J., 7052
asil'ev,G.F., 7055
assamillet,L.F., 7508
aughan,F., 7587
aughan,P.A., 7642
azquez,D., 6799
edder,J., 7271
edenov,A.A., 7114
enema,A., 6608

Venkatesan,D., 7142
Vescan,T.T., 7296
Vestergaard,R., 7375
Vigier,J.P., 6498
Vigone,M., 7285
Vijayaraghavan,R., 7195
Villi,C., 7357
Vinogradov,D.P., 7083
Vitale,B., 7287
Voigt,J., 6759
Völcker,H., 7383
Volokhova,Z.V., 7463
von Roos,O., 7409
Vroelant,C., 7444

Wada,A., 6878-9
Waddington,C.J., 7132, 7136, 7699
Wade,C., Jr, 6822
Wagenbreth,H., 6852
Wagner,E.L., 6728
Wagner,P., 7557-8
Waldmeier,M., 6455, 6463-4
Waldron,R.D., 7220
Walecka,J.D., 6523
Walker,D.M.C., 6473
Walker,W.C., 6777
Wall,F.T., 7479, 7480
Wall,L.A., 7180
Wall,R.A., 7474
Walling,J,F., 6842
Wallis,G., 6950
Wallis,R.F., 6935
Walraven,P.L., 7701
Walther,K., 7214
Walton,A.K., 7009
Wang,S., 6950
Warburton,E.K., 7342
Ward,R.L., 7448
Ward,W.D., 7711-12
Washer,F.E., 6685
Watanabe,K., 7118
Watanabe,S., 7256
Waters,W.E., 7071
Watson,L.R., 7518
Watters,B.G., 6651
Wayman,P.A., 6443
Waynick,A.H., 7676
Weatherly,T.L., 6743, 7467
Weaver,H.E., 7187
Webb,L.A., 7521
Weber,J., 7363
Webley,R.S., 7165
Webster,H.F., 7075
Weeks,R.F., 6776
Wehner,G., 7540
Wehner,G.K., 7541
Wei,C.C., 6500

Weibel,E.S., 7094, 7112
Weigang,O.E.,Jr, 7429
Weill,R., 7253-4
Wein,C.G., 6790
Weiner,R., 7309
Weinmann,A., 6643
Weinreich,G., 6961, 6969
Weinstock,H., 6823
Weiss,G.H., 7492
Weiss,H.G., 6738-9
Weiss,R.J., 7651, 7657
Weissler,G.L., 6777, 7126
Weizel,W., 7120-1
Welker,H., 6936
Weller,R.I., 6477
Welsh,H.L., 6725
Wenking,H., 6808
Werner,E., 6535
Wernick,J.H., 7171, 7507, 7509
Westberg,R.G., 7025
Westheimer,G., 7704
Westmacott,K.H., 7044, 7510
Weston,D.E., 6629
Weston,R.E., Jr, 7572
Westrum,E.F., Jr, 6854
Whelan,J.M., 6948, 7551
Whetten,N.R., 7068
White,A.D., 7031
White,D.L., 6901
White,H.G., 6969
Wichmann,E.H., 6538
Widder,F., 7116
Wild,R.L., 7554
Wilde,K.A., 6838
Wilkes,J.G., 7595
Wilkinson,P.G., 6720
Williams,F., 6617
Williams,F.E., 6920
Williams,G., 6870, 6872
Williams,G.A., 7454
Williams,H.J., 7161
Williams,I., 7152
Williams,I.B., 6613
Williams,Q., 6743, 7467
Williams,R.E., 7464
Williams,T.R., 6662
Williams,W., 7010
Wilmshurst,J.K., 7455
Wilson,B.G., 7138
Wilson,R., 7343
Wilson,V.C., 7073
Winckler,J.R., 7686
Wing,J., 7351-2
Winter,R.G., 6522
Winterberg,F., 7384
Wittenborn,A.F., 6655
Wolfsberg,M., 7572

Wolsky,S.P., 7522
Wolter,H., 6553
Wolter,W., 7244
Woodbury,H.H., 7186
Woodward,A.E., 7474
Woolfson,M.M., 7628, 7630, 7641
Work,R.N., 6869
Works,C.N., 7019
Wright,D.A., 7014
Wright,S.B., 7225
Wright,W.D., 6814
Wuerker,R.F., 7095
Wuest,W., 6569
Wunderer,P., 7265
Wyckoff,H.W., 7609
Wyllie,M.R.J., 7660
Wyluda,B.J., 7197
Wynne,C.G., 6693
Wyszecki,G., 6810

Yamaguchi,S.,7082
Yamazaki,M., 7440
Yamazaki,T., 7324
Yang,C.N., 6537
Yankwich,P.E., 7580
Yarnell,J.L., 6846-7
Yatsiv,S., 7190-1
Yavnel'.A.A., 6451
Yekutieli,G., 7279
Yih,C.S., 6830
Yoder,P.R., Jr, 6819
Yoshié,K., 6673
Yoshino,T., 6748
Yotsumoto,H., 7545
Young,L., 6894

Zachariasen,W.H., 7649
Zago,G., 7226
Zaidel',A.N., 6756, 7402
Zappa,L., 7326
Zastenker,G.N., 7022
Zdanis,R., 7005
Zemel,J.N., 6957
Zhuze,V.P., 6941
Zigan,F., 6603
Zimányi,J., 7242
Zinov'eva,K.N., 6849
Zinsser,H.H., 6646
Zoli,M.T., 6689
Zorn,G.T., 7284
Zucker,A., 7355
Zumino,B., 7476
Zutshi,P.K., 7695
Zwerdling,S., 6970-1
Zȳkov,G.A., 7063

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Slope Resistance at 25°C Max. Limit	20 ohms	19 ohms	18 ohms	17 ohms	12 ohms	10 ohms
Slope Resistance at 25°C Min. Limit	15 ohms	14 ohms	12 ohms	12 ohms	6 ohms	5 ohms
TYPE	VR575B-B	VR625-B	VR7-B	VR8-B	VR9-B	VR10-B
Voltage Range	5·4–6·1	5·9–6·6	6·4–7·6	7·4–8·6	8·4–9·6	9·4–10·6
Slope Resistance at 25°C Max. Limit	5 ohms	4 ohms	4 ohms	4 ohms	4 ohms	5 ohms
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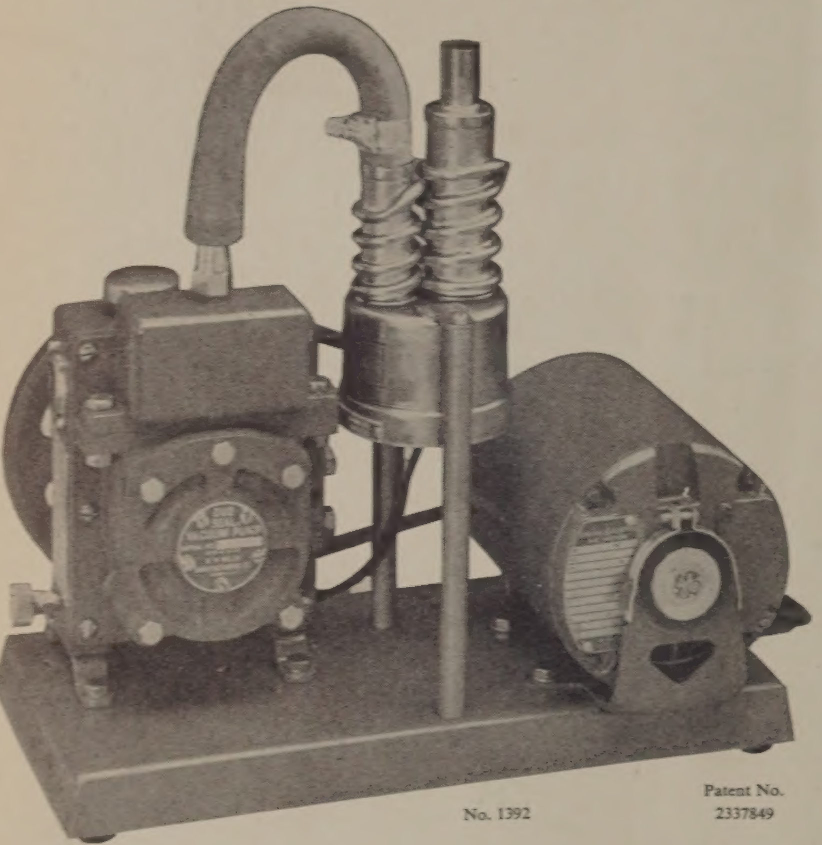

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